PATENT

IN THE UNITED STATES

PATENT AND TRADEMARK OFFICE

APPLICANT:	Eric C. Anderson
APPLICATION NO.:	REI of USPN 6,011,585
FILING DATE:	HEREWITH
TITLE:	APPARATUS AND METHOD FOR ROTATING THE DISPLAY ORIENTATION OF A CAPTURED IMAGE
EXAMINER:	UNKNOWN
GROUP ART UNIT:	UNKNOWN
ATTY. DKT. NO.:	18602-06614 (P1450R1)

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COMMISSIONER FOR PATENTS
WASHINGTON, DC 20231

EXPRESS MAIL NO. EL734639335US

INFORMATION DISCLOSURE STATEMENT
Under 37 CFR §§ 1.56 and 1.97-98

SIR:

Pursuant to the provisions of 37 CFR §§ 1.56 and 1.97-98, enclosed herewith is modified form PTO-1449 listing references for consideration by the Examiner. A copy is enclosed herewith of each listed reference which may be material to the examination of this application, and with respect to which there may be a duty to disclose.

The filing of this Information Disclosure Statement shall not be construed as a representation regarding the completeness of the list of references, or that inclusion of a reference in this list is an admission that it is prior art or is pertinent to this application, or that a search has been made, or as an admission that the information listed is, or may be considered to be, material to patentability, or that no other material information exists, and shall not be construed as an admission against interest in any manner.

☒ This application relies, under 35 U.S.C. § 120, on the earlier filing date of prior U.S. Patent No. 6,011,585, issued on January 4, 2000, and the references cited therein are hereby referenced, but are not required to be provided in this application under 37 CFR § 1.98(d). However, copies of the references are provided for the Examiner's convenience.

The Information Disclosure Statement submitted herewith is being filed:

☒ within three months of the filing date of the application, or date of entry into the national stage of an international application, or before the mailing date of a first official action on the merits, whichever event last occurred; OR

☐ before the mailing of a first official action after the filing of a request for continued examination (RCE) under 37 CFR § 1.114;

☐ after three months of the filing date of this national application or the date of entry of the national stage in an international application, or after the mailing date of the first official action on the merits, whichever event last occurred, but before the mailing date of the first to occur of either:

- (1) a final action under 37 CFR §1.113; OR
- (2) a notice of allowance under 37 CFR §1.311; AND
- ☐ attached hereto is the fee of $180, as set forth under 37 CFR §1.17(p), for submission of this Information Disclosure Statement under 37 CFR.§ 1.97(c); OR
- ☐ Applicant certifies pursuant to 37 CFR § 1.97(e) that:
  - ☐ each item of information contained in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Statement; OR
  - ☐ no item of information contained in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application or, to the knowledge of the person signing this certification after making reasonable inquiry, was known to any individual designated under 37 CFR § 1.56(c) more than three months prior to the filing of this Statement.

OR

☐ before the payment of the issue fee but after the mailing date of the first to occur of either:

- [1] a final action under 37 CFR § 1.113; OR
- [2] a notice of allowance under 37 CFR § 1.311; AND

  in accordance with the requirements of 37 CFR § 1.97(d):
- ☐ Applicant certifies pursuant to 37 CFR. § 1.97(e) that:

☐ each item of information contained in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Statement; OR

☐ no item of information contained in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application or, to the knowledge of the person signing this certification after making reasonable inquiry, was known to any individual designated under 37 CFR § 1.56(c) more than three months prior to the filing of this Statement; AND

☐ Applicant hereby respectfully petitions for the consideration of the accompanying Information Disclosure Statement under 37 CFR § 1.97(d)(2); AND

☐ Applicant submits the petition fee of $180 as set forth in 37 CFR § 1.17(p).

☐ Each item of information contained in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart application, and the communication was not received by any individual designated in 37 CFR § 1.56(c) more than thirty days prior to the filing of this Information Disclosure Statement. 37 CFR § 1.704(d).

☒ Applicant submits that no fee is required for the consideration of the accompanying Information Disclosure Statement.

Consideration of the listed references and favorable action are solicited.

Respectfully submitted,

ERIC C. ANDERSON

Dated: January 4, 2001

By: ______________________

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Sheet 1 of 1

FORM PTO-1449 (REV. 6-89) U S DEPARTMENT OF COMMERCE Patent and Trademark Office	Attorney's Docket No. 18602-06614	Application No REI of USPN 6,011,585
INFORMATION DISCLOSURE CITATION (Use several sheets if necessary)	Applicant Eric C. Anderson	
	Filing Date HEREWITH	Group Art Unit UNKNOWN

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date If Appropriate
	A1	5,521,639	05/28/96	Tomura *et al.*	348	243	
	A2	5,218,459	06/08/93	Parulski *et al.*	358	451	
	A3	4,364,650	12/21/82	Terashita *et al.*	354	31	
	A4	3,971,065	07/20/76	Bayer	358	41	
	A5	3,814,227	06/04/74	Hurd, III *et al.*	197	1 R	

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		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
	B1	4-120889	4/1992	Japan	H04N	7/14	X	

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

EXAMINER	DATE CONSIDERED

EXAMINER: Initial if references considered, whether or not citation is in conformance with MPEP § 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant

PTO-1449
REV: 12/96

18602/06614/SF/5066098.1

US005521639A

United States Patent [19]

Tomura et al.

[11] **Patent Number: 5,521,639**

[45] **Date of Patent: May 28, 1996**

18602-06614 : A1

[54] **SOLID-STATE IMAGING APPARATUS INCLUDING A REFERENCE PIXEL IN THE OPTICALLY-BLACK REGION**

[75] Inventors: **Masaharu Tomura**, Kanagawa; **Kikue Shimokawa**, Tokyo, both of Japan

[73] Assignee: **Sony Corporation**, Tokyo, Japan

[21] Appl. No.: **314,199**

[22] Filed: **Sep. 28, 1994**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 45,126, Apr. 12, 1993, abandoned.

[30] **Foreign Application Priority Data**

Apr. 30, 1992 [JP] Japan 4-135703

[51] **Int. Cl.**[6] **H04N 3/14**

[52] **U.S. Cl.** **348/243**; 348/245

[58] **Field of Search** 348/243, 241, 348/245, 294; 257/223, 229

[56] **References Cited**

U.S. PATENT DOCUMENTS

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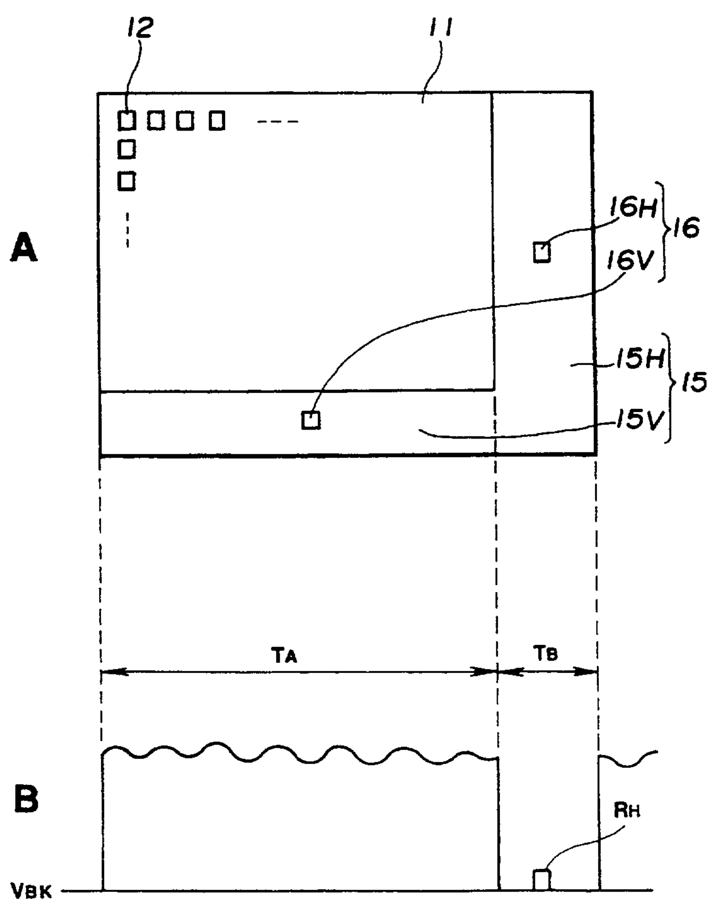
Primary Examiner—Wendy R. Greening
Attorney, Agent, or Firm—William S. Frommer; Alvin Sinderbrand

[57] **ABSTRACT**

Solid-state imaging apparatus for producing an image signal has an active pixel region comprised of a plurality of active light receiving pixels for converting incident light to an image signal, and an optical black region disposed at the peripheral portion of the active pixel region and comprised of a plurality of pixels having a surface provided with a light shield. At least one pixel in the optical black region is located at a predetermined position and produces a position reference signal of a level which differs from that produced by the remaining pixels in the optical black region.

7 Claims, 6 Drawing Sheets



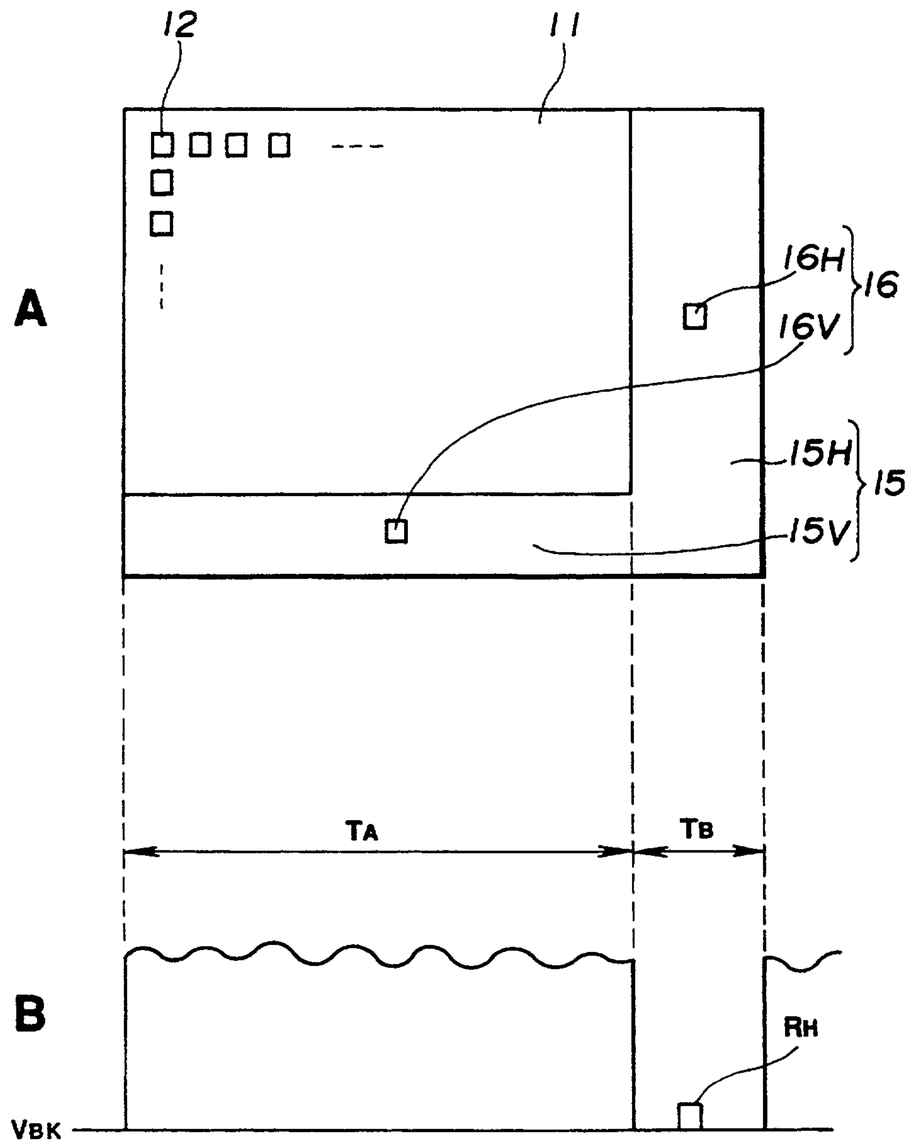


FIG.1

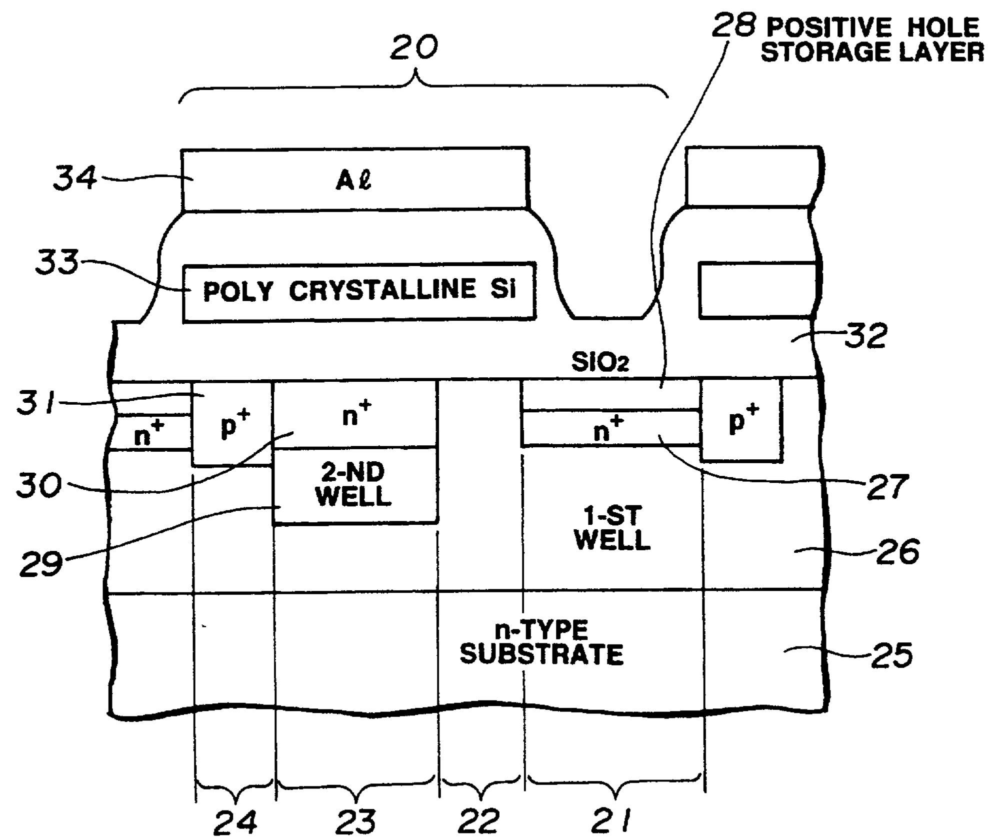

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FIG.2

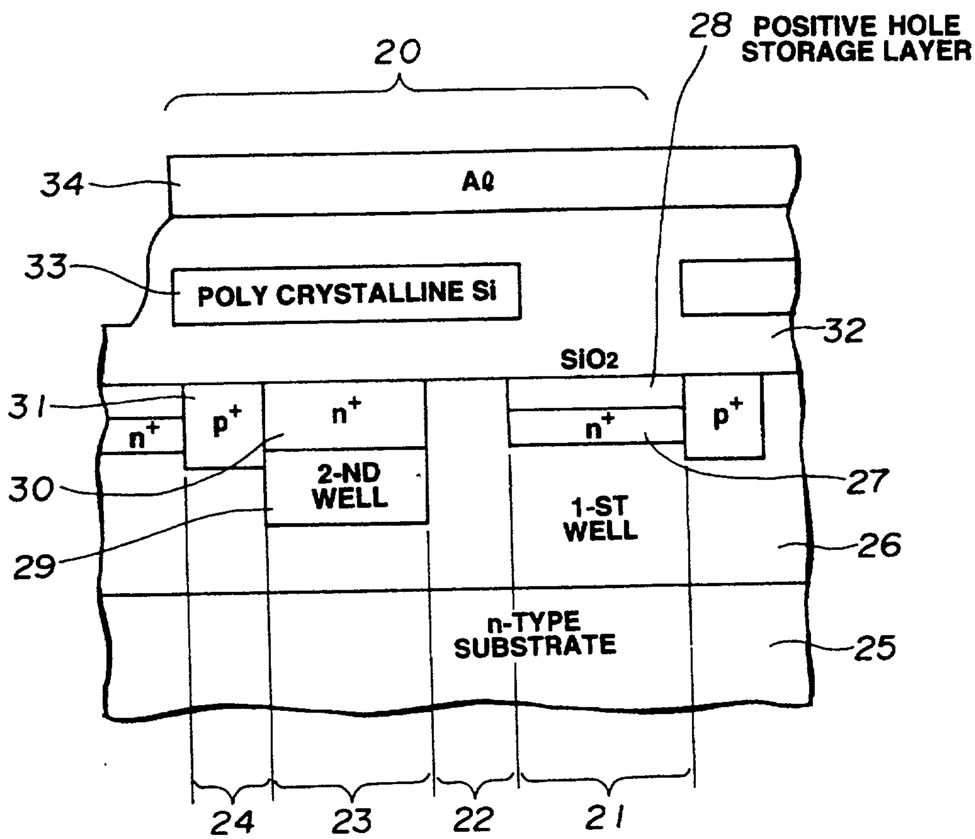
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FIG.3

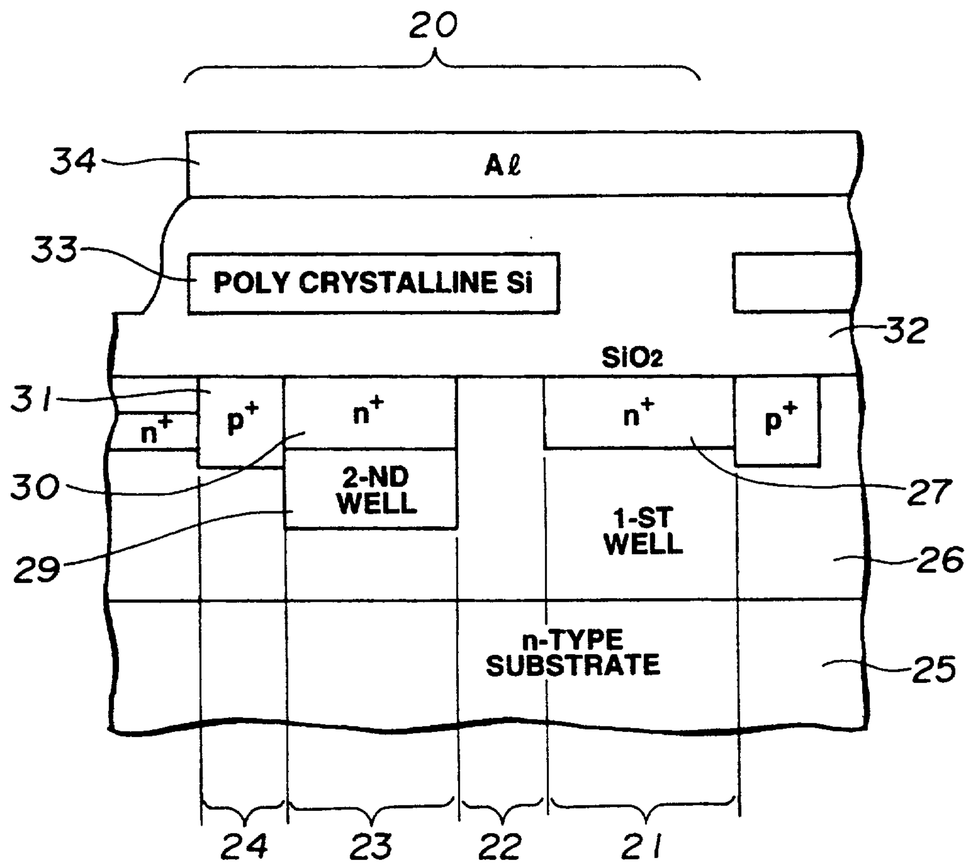
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FIG.4

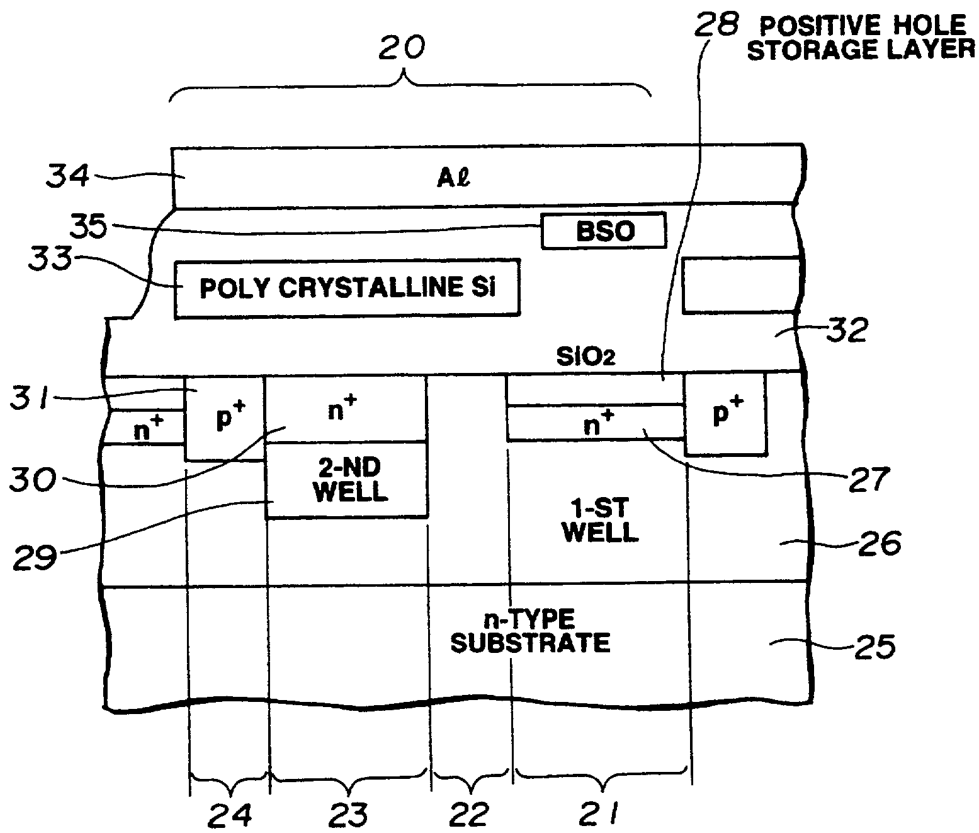
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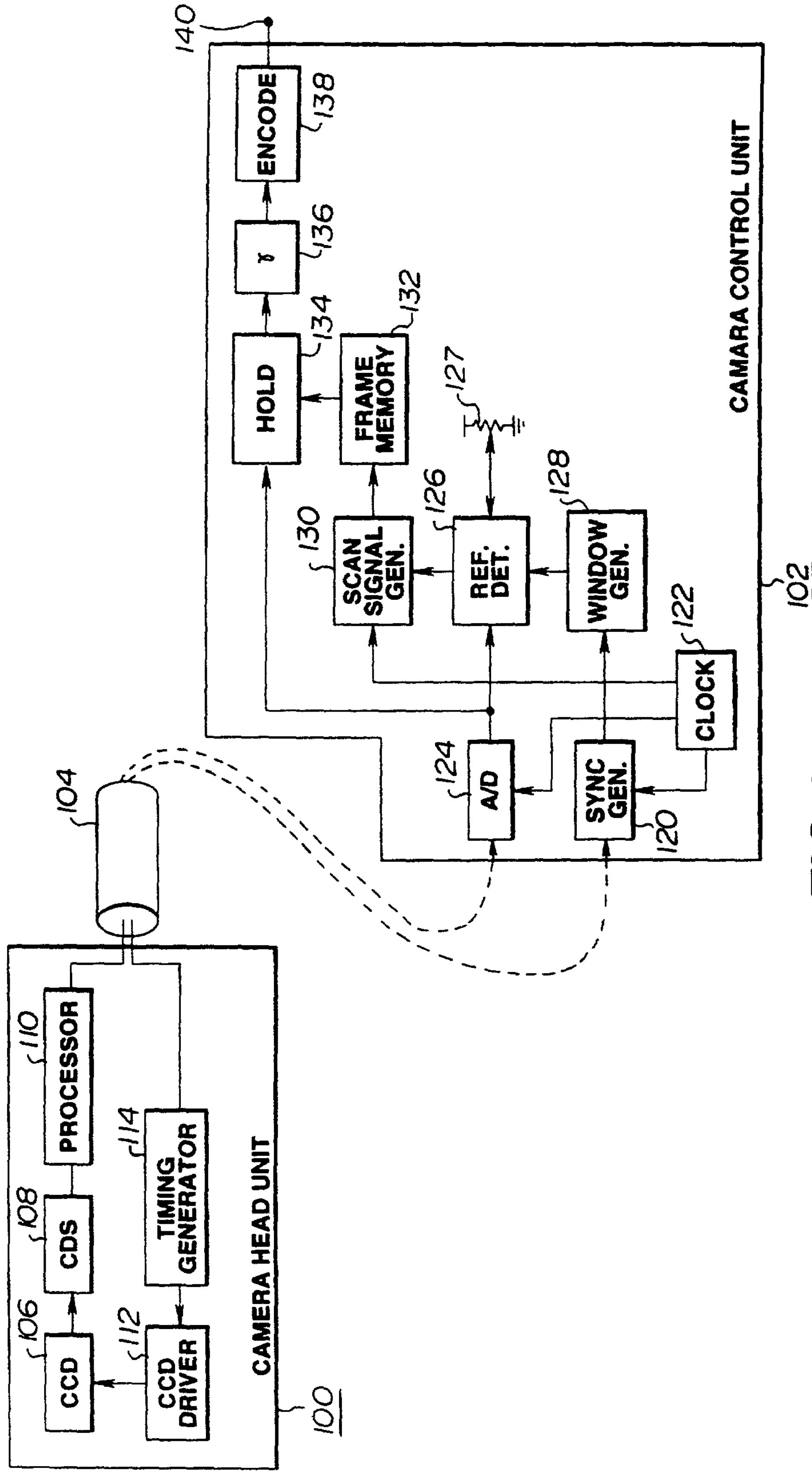
FIG.5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CAMARA CONTROL UNIT
102
CLOCK
122
A/D
124
SYNC GEN.
120
104
PROCESSOR
110
CDS
108
CCD
106
TIMING GENERATOR
114
CCD DRIVER
112
CAMERA HEAD UNIT
100

FIG.6

SOLID-STATE IMAGING APPARATUS INCLUDING A REFERENCE PIXEL IN THE OPTICALLY-BLACK REGION

This is a continuation-in-part of application Ser. No. 08/045,126, filed Apr. 12, 1993 now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to a solid-state imaging apparatus, and more particularly, to a solid-state imaging apparatus including an active pixel region comprised of a plurality of active light receiving pixels to produce output signals as a function of impinging light and an optical black region arranged at the periphery of the active pixel region and comprised of a plurality of pixels which are effectively non-responsive to impinging light.

In a solid-state imaging apparatus using CCDs (Charge Coupled Devices), when signal processing is carried out for every light image pickup element, or pixel (cell), for example, when correcting for a defective pixel, or providing digital shading correction, etc., a timing signal from a timing generator is used as a pixel position reference signal. In a so-called self-contained video camera, the timing generator is included in a camera control circuit which is contained, or housed, in the camera body.

A non-self-contained video camera is formed of a camera head unit which includes an optical system, an imaging section which is comprised of the pixels, etc., and a separate camera control unit (CCU) for controlling the operation of the video camera. A measurable time delay is imparted to the transmission of a video signal from the camera head unit to the camera control unit, giving rise to a delay of the video signal. Likewise, a timing signal from the timing generator in the CCU, and which is supplied to the camera head unit for the purpose of driving the CCDs, undergoes a delay. Such delays often are changeable as a function of temperature, age and other factors, and thus are unpredictable. For this reason, it is difficult, if not impossible, simply to use a signal from the timing generator as a pixel position reference signal. Although it is conceivable to use the horizontal synchronizing signal as a reference, it is difficult to insure the accuracy thereof for use as a reference it for an individual pixel.

OBJECTS OF THE INVENTION

Therefore, an object of this invention is to provide a solid-state imaging apparatus adapted for outputting a pixel position reference signal together with an image signal.

Another object of this invention is to provide apparatus for detecting and compensating for a defective pixel in a CCD pickup unit.

Various other objects, advantages and features of the present invention will become readily apparent from the following detailed description and the novel features will be particularly pointed out in the appended claims.

SUMMARY OF THE INVENTION

In accordance with this invention, a solid-state CCD video imaging apparatus comprises an active pixel region formed of a plurality of active light receiving elements, or pixels, for converting incident light to a video signal, and an optical black region disposed at the periphery of the active pixel region and comprised of a plurality of pixels on whose surface is provided a light shield or light screen. A predetermined pixel within the optical black region is caused to generate a pixel position reference signal whose level differs from the level of the output signals produced by the other pixels in the optical black region. As a result, when the active and optical black regions are scanned during normal operation of the CCD apparatus, both the image signal and the pixel position reference signal are produced. If an active pixel is defective, the signal produced by that pixel is compensated.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a schematic diagram showing an embodiment of a solid-state CCD imaging apparatus according to this invention;

FIG. 1B schematically represents the output signals produced by a row of pixels in FIG. 1A;

FIG. 2 is a schematic cross-sectional view for explaining the structure of an active pixel of the solid-state imaging apparatus shown in FIG. 1;

FIG. 3 is a schematic view of the structure of a pixel in the optical black region of the imaging apparatus;

FIG. 4 is a schematic view of one embodiment of a reference pixel in the optical black region;

FIG. 5 is a schematic view of another embodiment of the reference pixel; and

FIG. 6 is a block diagram of apparatus for detecting and compensating the image signal produced by a defective pixel.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Preferred embodiments of this invention will now be described with reference to the attached drawings.

FIG. 1A illustrates the configuration of an embodiment of a solid-state CCD imaging apparatus according to this invention and FIG. 1B schematically illustrates the signals produced by that apparatus.

FIG. 1A includes an active pixel region **11** formed of a plurality of pixels **12** arranged in a two-dimensional matrix extending lengthwise and breadthwise. Light irradiated through a lens system (not shown) is effectively received in region **11** to produce output image signals at each pixel. An optical black region extends over the right side portion **15H** and the lower side portion **15V** around the periphery of active pixel region **11**. This optical black region is such that incident light is blocked from impinging thereon; for example, an aluminum film is deposited and formed on the surface thereof as a light shield or light screen (referred to herein as a shield). No light is detected in the optical black region, and a signal having a predetermined black level (optical black level) is thus outputted therefrom at all times.

In accordance with this invention, a predetermined number of position reference pixels **16** are disposed at predetermined positions within the optical black region **15** to output a signal of a fixed level which is different from the optical black level. In the example of FIG. 1A, a single horizontal position reference pixel **16H** is provided at the right side portion **15H** within the optical black region **15** and a single vertical position reference pixel **16V** is provided at the lower side portion **15V** within the same region.

FIG. 1B is illustrative of an example of an output video signal waveform produced when a line (scanning line) of pixels including the horizontal position reference pixel **16H** is scanned. The time period T_A of this waveform corre-

sponds to the time period during which the pixels in the active pixel region 11 are scanned, and the time period T_B thereof corresponds to the time period during which the right side portion 15H of the optical black region 15 is scanned. The signal produced during this time period T_B exhibits a predetermined optical black level V_{BK}. However, when the horizontal position reference pixel 16H is scanned, a pulse R_H is generated at a level different from the optical black level V_{BK}. The detection of this pulse level R_H is used as a pixel reference position signal.

Since the pixel reference position signal is derived from the video signal itself, that is, from the image signals produced by the CCD imaging apparatus, even if a delay is imparted to the transmission of the image signals from the camera head unit to the camera control unit, as is expected in a non-self-contained video camera, there is no difficulty in using the pulse R_H as a reference signal because this reference signal undergoes the same delay as the active portion (or image information portion) of the image signal. Hence, video information from particular pixels referenced to this position reference pixel may be sensed with high accuracy.

While the horizontal position refrence pixel 16H is used as a reference position in the horizontal direction, vertical position reference pixel 16V may be used as a reference position in the vertical direction.

The above-mentioned position reference pixel 16H or 16V may be located at any desired position in the horizontal or vertical direction within the optical black region 15. Hence, when the operating parameters for the video camera timing generator are being selected, as during the manufacture thereof, the coordinates of the position reference pixels may be freely set. In order to output a signal of a fixed level, such as R_H, which can be readily discriminated from the optical black level V_{BK} when the position reference pixel 16H or 16V is scanned, it is proposed to remove the light shield (such as the aluminum film or the like) normally deposited on the pixels in the optical black region, to thereby open a window only at the reference position in this portion. Another proposal for the position reference pixel is to provide a light emitting element, such as an element capable of emitting an infrared ray or the like, formed on a chip disposed opposite the usual light receiving section (sensor section) of the position reference pixel; and to form a light shield, such as the usual aluminum film, so that no external light impinges onto the position reference pixel except for the light that is emitted by the light emitting chip. When using such a light emitting chip, it is appreciated that suitable precautions should be taken to obviate, or at least minimize, the transmission, leakage, or diffraction of light onto other portions of the optical black region from the light emitting chip.

As a further proposal, the position reference pixel may be constructed to produce a larger dark current (dark current quantity) from the light receiving section (sensor section) thereof by omitting from the position reference pixel the positive hole storage layer normally overlying the n+ region of the sensor section. As a result, the surface state is in correspondence with a depleted state only at the position reference pixel in the optical black region. Reference is made to the solid-state imaging apparatus described in "High Sensitivity Interline type CCD of minimum illuminance 51x" Nikkei Micro Device, October, 1987, pp. 60–67.

An active pixel adapted to be used in active pixel region 11 of FIG. 1A is described in the above-mentioned literature and is schematically illustrated herein in FIG. 2. This active

pixel is adapted to store positive holes on the surface of a substrate to thereby suppress the dark current which otherwise would be generated. The structure of a single pixel 20 is comprised of a light receiving section (sensor section) 21, a readout gate 22, a vertical register 23, and a channel stopper 24. A first p-well region 26 is formed on an n-type silicon substrate 25. An n^+ region 27 is formed at the sensor section 21 within the p-well region 26. Further, a positive hole storage layer 28 is formed above the n^+ region 27.

In the vertical register 23, a second p-well region 29 is formed within the first p-well region 26, and an n^+ region 30 is formed above the second p-well region 29. The channel stopper 24 is comprised of a p^+ region 31 formed above the p-well region 26.

A SiO_2 film 32 is formed as an insulating layer by depositing same on the upper surface of n^+ region 30, p-well region 26, positive hole storage layer 28 and p^+ region 31. A polycrystalline Si layer 33 serving as an electrode is formed in the SiO_2 film so as to cover the readout gate 22, the vertical register 23 and the channel stopper 24 through the SiO_2 insulating layer. Further, an Al (aluminum) layer 34 is deposited on the upper surface of the SiO_2 insulating layer and serves as a light shield. That portion of the Al layer 34 which overlies sensor section 21 is removed to permit light to pass through the transparent SiO_2 layer.

In general, solid-state imaging devices, whether they exhibit high or low sensitivity, admit of a problem when imaging is carried out at low luminance because of the dominant fixed pattern noise attributed to dark current rather than light shot noise. To improve the sensitivity of the imaging device, the absolute value of the dark current is reduced.

Dark current includes, as a main component, a diffusion current which flows into the pixel from the substrate or the neutral region, a current produced as a result of the surface state of the sensor section and a current produced as a result of the surface state of the vertical register section. In order first to reduce the current component (i.e. electrons) which flows into the pixel by diffusion from the substrate, the p-well region 26 is formed on the n-type substrate 25 so as to particularly allow the p-well region to operate in a depleted state, thus to substantially completely suppress the diffusion component from the neutral region. With respect to the current produced on the surface of the sensor section, positive hole storage layer 28 allows positive holes to be stored and thereby suppress this current, as described more particularly in U.S. patent application Ser. No. 08/34,784. The current produced on the surface of the vertical register section is also suppressed in accordance with a similar principle. Positive holes are stored by a voltage applied to the gate electrode (the polycrystalline Si layer 33), thus to reduce the absolute value of that component of the dark current produced from the surface of the vertical register section 23

Pixels having the structure shown in FIG. 2 are disposed in the active pixel region 11 of FIG. 1 and pixels having a similar structure, but wherein the light shield, or Al layer 34, extends over sensor section 21, as shown in FIG. 3, are disposed in the optical black region 15. A pixel having the structure shown in FIG. 4 is used as the position reference pixel. Here, the positive hole storage layer 28 overlying the sensor section 21 of FIG. 3 is omitted and the n^+ region 27 extends to the SiO_2 insulating layer As a result, the sensor section 21 of the pixel shown in FIG. 4 operates in a depleted state so that the dark current at this portion (horizontal and vertical position reference pixels 16H, 16V) is larger than

the dark current at other portions of the optical black region. Consequently, a signal of a fixed level greater than the optical black level V_{BK} is obtained; and this signal can be detected as the pixel position reference signal R_H.

Yet another embodiment of a pixel structure which can be used as the position reference pixel is illustrated in FIG. 5. Here, the pixel structure used in the optical black region, and shown in FIG. 3, is modified by depositing in the SiO_2 insulating layer **32** a light-emitting element **35** formed of $Bi_{12}SiO_{20}$, generally referred to as a BSO chip. When a voltage is applied to the polycrystalline layer **33**, the BSO chip is activated to emit light which passes through the transparent SiO_2 insulating layer to produce a current which results in a readily detectable level that is substantially greater than the optical black level V_{BK}. Thus, when the position reference pixel shown in FIG. **5** is scanned, the signal produced thereby is indicative of the scanning of horizontal position reference pixel **16H** or vertical position reference pixel **16V**, respectively.

It is readily appreciated that, since the position reference pixel having the structure shown in FIG. 4 or FIG. 5 produces an easily detectable signal, the occurrence of that signal as pixels in the optical black region are scanned results in a reference signal, such as the reference pulse R_H shown in FIG. **1B**, which can be used as a reference position from which any one of the active pixels located in active region **11** can be precisely identified. The manner in which the position reference pixel is used to identify pixels in the active region, and to accurately detect and compensate for a defective pixel now will be described in conjunction with the block diagram shown in FIG. **6**.

FIG. **6** illustrates a non-self-contained video camera comprised of a camera head unit **100**, a camera control unit **102** and a cable **104** which supplies image signals from the camera head unit to the camera control unit and also supplies synchronizing signals from the camera control unit to the camera head unit. The camera head unit includes a solid-state imaging device, illustrated herein as a CCD pickup **106** which may have the structure diagrammatically illustrated in FIG. 1A. It is appreciated, therefore, that CCD pickup **106** includes an array of active pixels disposed in an active region **11**, an array of optical black pixels disposed in an optical black region **15** and position reference pixels **16H** and **16V** which may exhibit the structure shown in FIGS. 4 or 5. Camera head unit **100** additionally includes a sampling circuit **108**, which may be a correlated double sampling (CDS) circuit, a sample signal processor **110**, a CCD driver **112** and a timing generator **114**. As shown, CCD pickup **106** is driven by CCD driver **112** which, in turn, operates to scan the active and optical black pixels included in the CCD pickup in response to timing signals supplied to the CCD driver by timing generator **114**. The timing generator is, in turn, driven by synchronizing signals supplied thereto from camera control unit **102** via cable **104**. In the illustrated embodiment, these synchronizing signals are generated in the camera control unit by a sync generator **120**. It will be appreciated that, because of the length of cable **104**, a time delay is imparted into the synchronizing signals supplied to timing generator **114** from sync generator **120** Thus, from the viewpoint of considering the synchronizing signal produced at the sync generator, there is a discrete time delay between that synchronizing signal and the reading of a corresponding pixel as that pixel is scanned by CCD driver **112**.

Processor **110** functions to adjust the gain, black level, etc., of the sampled levels produced by each pixel as those pixels are scanned by CCD driver **112** Hence, and as is known to those of ordinary skill in the art, processor **110** produces suitably adjusted pixel image signals. These pixel image signals are supplied to camera control unit **102** over cable **104**; and a further delay relative to the aforementioned synchronizing signal produced by sync generator **120** is introduced into the pixel image signal that eventually reaches the camera control unit.

The camera control unit includes an analog-to-digital (A/D) converter **124**, a hold circuit **134**, a gamma correction circuit **136** and an encoder **138**. During normal operation, that is, if it is assumed that none of the active pixels included in CCD pickup **106** is defective, each pixel image signal supplied to the camera control unit is converted from analog form to digital form by A/D converter **124**, and each digital pixel image signal then is gamma-corrected by gamma corrector **136** and suitably encoded by encoder **138**. The resultant encoded image signals are provided at an output terminal **140**. During such normal operation, hold circuit **134** provides no active function and simply supplies to gamma corrector **136** each digitized pixel image signal.

It is expected, however, that in manufacturing CCD pickup **106**, one or more active pixels may be defective. That is, when light impinges upon a defective active pixel, the pixel signal produced thereby is not an accurate representation of the impinging light. In that event, rather than supply to output terminal **140** an error image signal, it is preferred simply to replace the erroneous signal produced by this defective pixel with the correct image signal produced by an adjacent efficacious pixel. For example, the pixel image signal produced by the preceding active pixel is used in place of the erroneous pixel image signal produced by the defective pixel. Hold circuit **134** thus operates to temporarily store, or hold, a pixel image signal for a time period substantially equal to the time needed to scan two successive pixels. As a result, the temporarily stored pixel image signal in hold circuit **134** is used once again in the event that the next pixel image signal is erroneous. Of course, if the next pixel image signal is correct, the temporarily stored preceding pixel image signal is not used. Rather, this next correct pixel image signal is supplied to gamma corrector **136**. Hold circuit **134** is selectively operated, that is, it is selectively triggered to use once again the pixel image signal temporarily stored therein, by a frame memory **132**.

Frame memory **132** stores a corresponding representation, or map, of all of the active and optical black pixels included in CCD pickup **106**. Thus, the frame memory may be thought of as a memory device which stores an array of signals, or flags, corresponding to the pixel arrangement shown in FIG. 1A. Preferably, frame memory **132** stores a "0" at those locations corresponding to non-defective pixels, specifically non-defective active pixels, and stores a "1" at those locations corresponding to defective active pixels. For convenience, each "1" may be thought of as a flag that is set and each "0" may be thought of as a flag that is reset. It is known to test all of the active pixels one-at-a-time during the manufacturing of CCD pickup **106**. As a result of such testing, each non-defective active pixel is known and each defective active pixel likewise is known. That is, the location, or coordinate, of each defective pixel is known and its corresponding location in frame memory **132** is loaded with a flag, or "1", which represents that such active pixel is defective Thus, when a pixel image signal produced by a defective pixel is supplied to camera control unit **102**, frame memory **132**, which stores the location of that defective pixel and, thus, senses when the pixel image signal supplied to the camera control unit is from that defective pixel, energizes hold circuit **134** to supply to gamma corrector **136**

the temporarily stored pixel image signal that had been produced by the preceding non-defective pixel.

Typically, frame memory **132** is addressed by a scan signal generator **130** which, in turn, is driven by a clock generator **122**. This clock generator also drives A/D converter **124** and sync generator **120**. The scan signal generator thus is expected to be driven in synchronism with sync generator **120** which, in turn, is expected to synchronize the scanning of CCD pickup **106** by CCD driver **112**. As a result, when pixel **1** supplies a pixel image signal to camera control unit **102**, scan signal generator **130** is expected to generate an address for frame memory **132** which corresponds to the location therein of pixel **1**. Likewise, when the pixel image signal produced by pixel **2** is supplied to the camera control unit, scan signal generator **130** is expected to address memory **132** representing the location therein corresponding to pixel **2**. As a result of this addressing, it is expected that when the image signal produced by pixel n is supplied to the camera control unit, a corresponding location in frame memory **132** is addressed. If that corresponding location has a "1" flag stored therein, thus representing that pixel n is defective, hold circuit **134** is triggered and the otherwise erroneous pixel image signal is compensated by replacing that pixel image signal with the previous correct pixel image signal. However, as a result of the aforementioned delay imparted to the synchronizing signal supplied from sync generator **120** to timing generator **114** and the further delay imparted to the pixel image signal supplied to A/D converter **124** from processor **110**, it is possible and even likely that, when the pixel image signal produced by pixel n is received by the camera control unit, scan signal generator **130** addresses a location in memory **132** corresponding to pixel (n−1). It will be appreciated, therefore, that because of this delay, an erroneous pixel image signal may, nevertheless, be supplied to gamma corrector **136** and the next-following correct pixel image signal may be replaced by the preceding erroneous signal.

This possible erroneous defective pixel compensation operation is avoided by the present invention which serves to reset, or preset, scan signal generator **130** to generate a predetermined memory address when position reference pixel **16H** or **16V** is scanned. This presetting of the scan signal generator is achieved by a reference detector **126** and a window generator **128**, as will now be described.

Reference detector **126** may be a comparator supplied with a reference signal, diagrammatically represented as being supplied by a reference source **127**, and is adapted to compare to this reference signal the digitized pixel image signals produced by A/D converter **124**. Reference detector **126** is enabled by window generator **128**, the latter being driven by sync generator **120**. It will be appreciated that the delay attributed to cable **104** is no greater than the time needed to scan one, two or three successive pixels of CCD pickup **106**. Thus, window generator **128** operates to generate a window pulse having a duration equal to the greatest delay imparted by cable **104** such that this window sufficiently surrounds the scanning of position reference pixel **16H**. The window generator also may be driven by sync generator **120** to generate another window pulse which effectively surrounds the scanning of reference position pixel **16V**. It will be recognized that suitable timing is used in window generator **128** to respond to the synchronizing signal produced by sync generator **120** to generate the aforementioned window pulses. Such timing will be readily and easily implemented by one of ordinary skill in the art. Thus, even with the expected but unpredictable delay attributed to cable **104**, window generator **128** generates a window pulse when the pixel image signal produced by reference position pixel **16H** is supplied to the camera control unit and also generates a window pulse when the pixel image signal produced by reference position pixel **16V** is supplied to the camera control unit.

Since the reference position pixels assume the structure shown in FIG. **4** or FIG. **5**, thus producing a reference pixel image signal of the type shown as reference pulse R_H in FIG. **1B**, reference detector **126** readily detects the occurrence of this reference pulse within the window generated by window generator **128**. For example, the reference signal supplied to the reference detector by reference source **127** may be a threshold level greater than the black level V_{BK}, but less than the expected level of the reference pulse R_H. Consequently, when reference position pixel **16H** is scanned, reference detector **126** presets scan signal generator **130** to an address corresponding to this reference position pixel, thereby addressing memory **132** at a location which also corresponds to this reference position pixel. Thereafter, the scan signal generator may be incremented by clock generator **122** to generate successive addresses for frame memory **132**; and it will be readily appreciated that such successive addresses now are in synchronism with the pixel image signals supplied to camera control unit **102** by the corresponding pixels of CCD pickup **106**. Likewise, the detection of the pixel image signal produced by position reference pixel **16V** presets scan signal generator **130** to address a location in memory **132** which corresponds to this reference position pixel.

Therefore, even though cable **104** may impart a delay to the pixel image signals supplied to the camera control unit relative to the clock signals produced by clock generator **122**, and even though this delay may not be accurately predictable, nevertheless the detection of the pixel image signals produced by the position reference pixels serves to synchronize the addressing of memory **132** with the reception of the pixel image signals produced by the active pixels, thereby permitting proper compensation when a defective pixel is scanned.

While the present invention has been particularly shown and described with reference to preferred embodiments, it will be readily appreciated by those of ordinary skill in the art that various changes may be made. For example, only a single reference position pixel can be used or, alternatively, three or more reference position pixels can be provided in the optical black region. Of course, the coordinates of the respective reference position pixels will be set when the CCD pickup is manufactured, and these coordinates are represented by the presetting of scan signal generator **130** when the corresponding reference position pixel is detected.

It also is contemplated that the reference position pixel need not be limited to the embodiment shown in FIG. **4** or the embodiment shown in FIG. **5**. Rather, the reference position pixel may adopt the very same structure as the active pixel shown in FIG. **2**. With this construction, the reference position pixel produces an output signal whose level is equal to that shown in FIG. **1B** during the active scanning period T_A, and this output signal is produced as a result of light impinging upon the reference position pixel.

It is intended that the appended claims be interpreted so as to cover the embodiments discussed above, those changes which have been mentioned and all equivalents thereto.

What is claimed is:

1. A solid-state imaging apparatus for producing an image signal, comprising:

an active pixel region comprised of a plurality of active light receiving pixels for converting incident light to an

image signal, said active pixel region having a peripheral portion; and

an optical black region disposed at said peripheral portion of said active pixel region and comprised of a plurality of pixels having a surface provided with a light shield, at least one of the pixels in said optical black region having an opening in said light shield for the passage of light, said at least one pixel being located at a predetermined position within said optical black region, to produce a reference position signal detectable relative to signals produced by the remaining pixels in said optical black region.

2. A solid-state imaging apparatus for producing an image signal, comprising:

an active pixel region comprised of a plurality of active light receiving pixels for converting incident light to an image signal, said active pixel region having a peripheral portion;

an optical black region disposed at said peripheral portion of said active pixel region and comprised of a plurality of pixels having a surface provided with a light shield; and

a predetermined one of the pixels in said optical black region having a sensor section, an insulating layer separating said sensor section from said light shield, and light emitting means positioned in said insulating layer between said light shield and said sensor section to irradiate light to said sensor section to produce a reference position signal detectable relative to signals produced by the remaining pixels in said optical black region.

3. A solid-state imaging apparatus for producing an image signal, comprising:

an active pixel region comprised of a plurality of active light receiving pixels for converting incident light to an image signal, said active pixel region having a peripheral portion; and

an optical black region disposed at said peripheral portion of said active pixel region and comprised of a plurality of pixels each having a surface provided with a light shield, a sensor section and a positive hole storage layer overlying said sensor section to minimize dark current reproduced by said pixel; and wherein at least one predetermined pixel in said optical black region having said positive hole storage layer omitted therefrom to produce a dark current of a magnitude greater than said minimized dark current, thereby producing a reference

position signal detectable relative to signals produced by the remaining pixels in said optical black region.

4. A solid state imaging apparatus, comprising:

an active pixel region comprised of a plurality of active light receiving pixels for converting incident light to an image signal, each active pixel having a structure which includes a sensor section and an insulating layer overlying said sensor section; and

an optical black region disposed adjacent said active pixel region, said optical black region being comprised of a plurality of optically black pixels for producing a black signal level, each optical black pixel having a structure substantially similar to the structure of said active pixel and additionally including a light shield provided on a surface thereof and overlying said sensor section, said optical black region being additionally comprised of at least one position reference pixel located at a predetermined position in said optical black region and having a structure which differs from the structure of said optical black pixels to produce a reference position signal detectable relative to signals produced by said optical black pixels.

5. The apparatus of claim 4 wherein said position reference pixel includes a p-well region, an insulating layer overlying said p-well region, a light shield overlying said insulating layer, a sensor section disposed in said p-well region, and a light transmissive opening in said light shield overlying said sensor section.

6. The apparatus of claim 4 wherein said position reference pixel includes a p-well region, an insulating layer overlying said p-well region, a light shield overlying said insulating layer, a sensor section disposed in said p-well region, and a light emitting element in said insulating layer between said light shield and said sensor section to irradiate light to said sensor section.

7. The apparatus of claim 4 wherein each optical black pixel includes a position hole storage area included in said sensor section to suppress dark current produced by said active pixel; and wherein said position reference pixel includes a p-well region, an insulating layer overlying said p-well region, a light shield overlying said insulating layer and a sensor section disposed in said p-well region, said sensor section omitting a positive hole storage area to increase the dark current produced by said position reference pixel.

* * * * *

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United States Patent [19]

Parulski et al.

[11] **Patent Number: 5,218,459**

[45] **Date of Patent: Jun. 8, 1993**

[54] **PRINT SCANNER WITH SOFT KEY VARIABLE MAGNIFICATION**

[75] Inventors: **Kenneth A. Parulski; Vance E. Cochrane; John C. Rutter,** all of Rochester, N.Y.

[73] Assignee: **Eastman Kodak Company,** Rochester, N.Y.

[21] Appl. No.: **760,438**

[22] Filed: **Sep. 16, 1991**

[51] **Int. Cl.[5]** **H04N 1/00**
[52] **U.S. Cl.** **358/451**
[58] **Field of Search** 358/451, 214–216, 358/487, 468; 350/429

[56] **References Cited**

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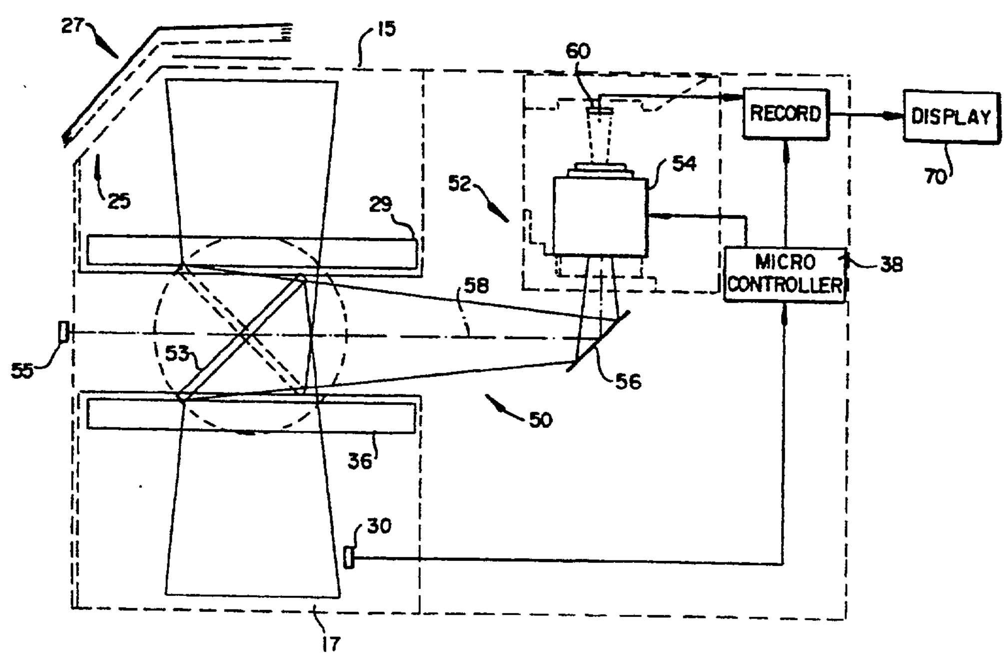
Primary Examiner—Stephen Brinich
Attorney, Agent, or Firm—Edward Dugas

[57] **ABSTRACT**

A zoom lens magnification control mechanism for a photoprint digitizing scanner contains an adjustable focus, zoom lens. The photoprint image projection path is incident upon a high resolution CCD sensor, image output signals from which are digitized for storage on a compact disc. Control of the operation of the scanner includes the use of a display device to which output signals provided by the photosensor are coupled so as to display the projected image. Whenever a photoprint is presented to the scanner an indication of the size of the photoprint is provided, as by way of a code stored on a photoprint platen, in order to set the magnification setting of the zoom lens. The photofinisher observes the display of the image projected on the photosensor and adjusts, as necessary, the operation of the zoom lens so that the image displayed by the display device fits the display screen. Using a program feature of a user interface, the photofinisher stores in memory information representative of the adjustment of the operation of zoom lens. Then, for subsequent presentations of photoprints to the scanner, the stored adjustment information is used as a magnification setting default value for a respective photoprint size. Whenever the magnification of the zoom lens is adjusted, there is an accompanying change in the focus ring of the lens, so that the displayed image is maintained in focus.

39 Claims, 12 Drawing Sheets



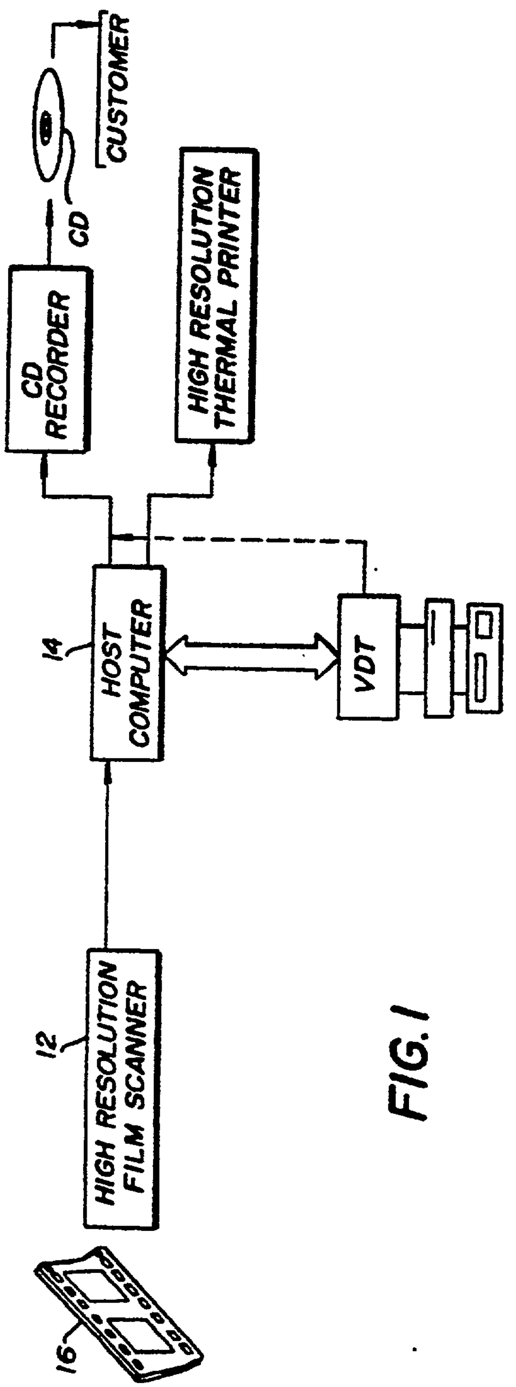

CUSTOMER
CD
CD RECORDER
HIGH RESOLUTION THERMAL PRINTER
14
HOST COMPUTER
VDT
12
HIGH RESOLUTION FILM SCANNER
16

FIG. 1

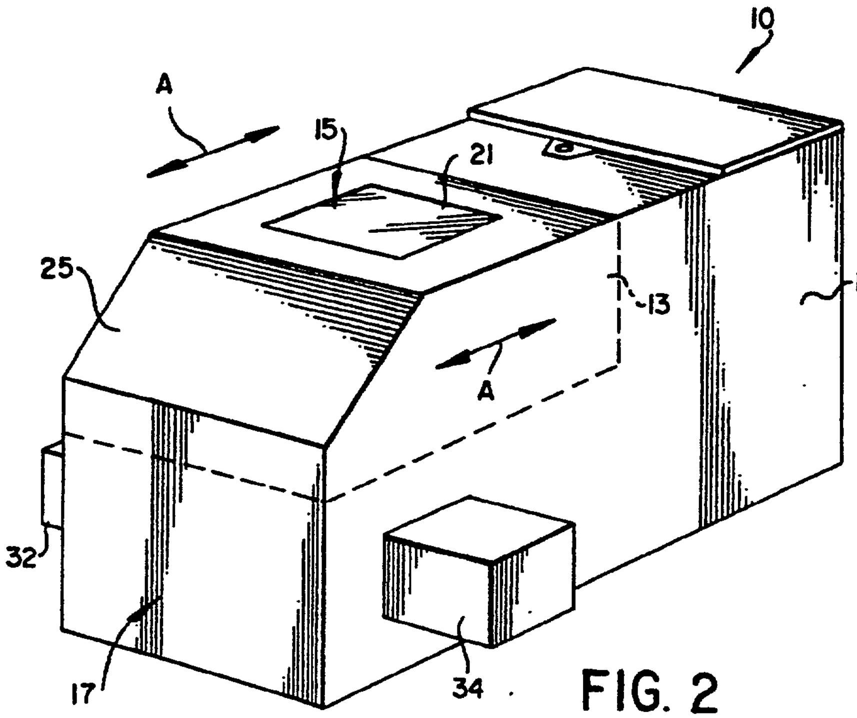


FIG. 2

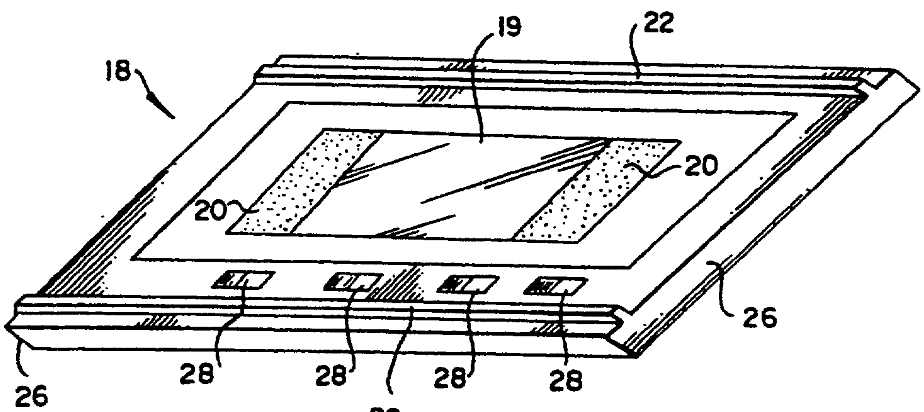
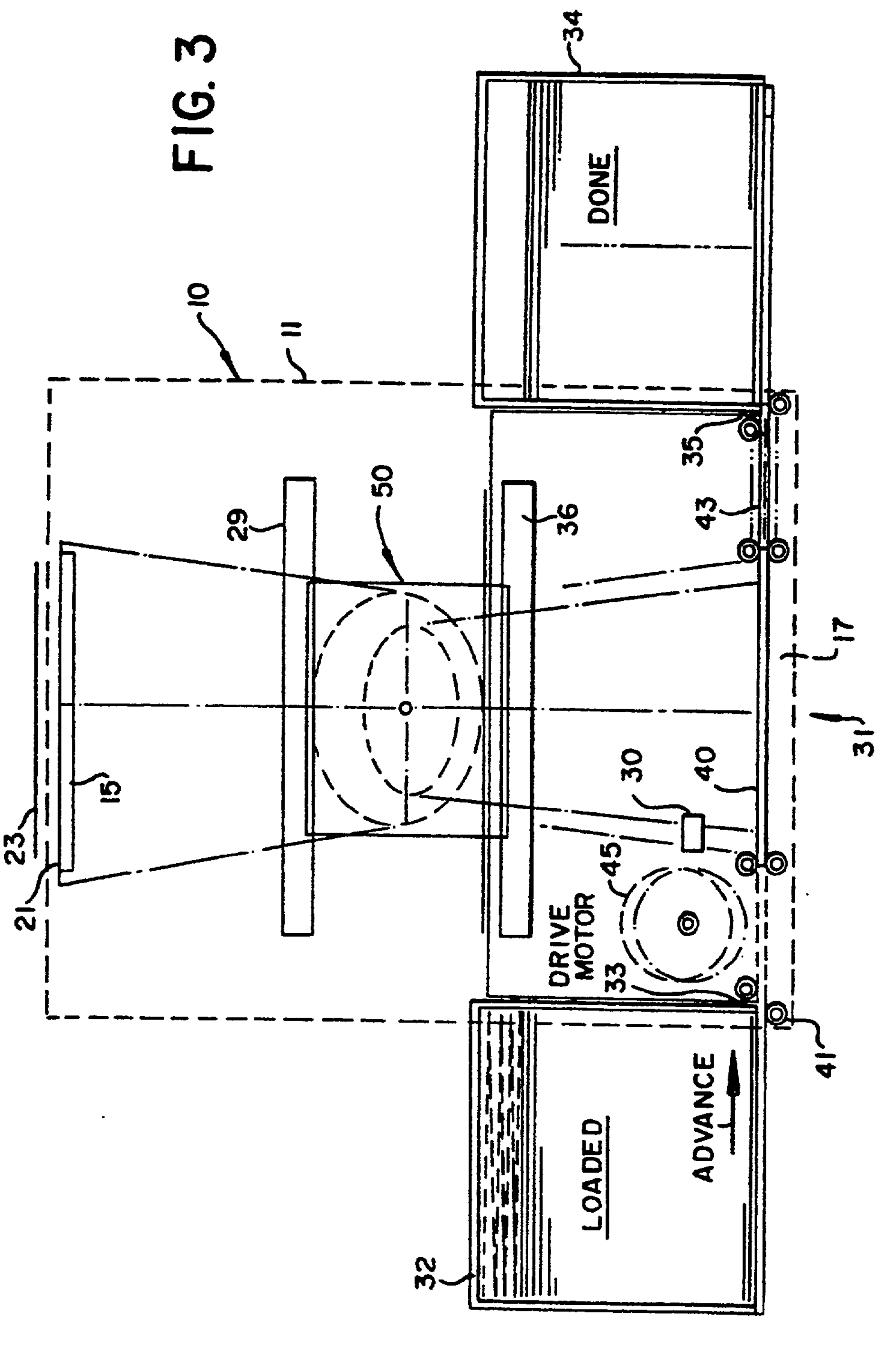


FIG. 5

FIG. 3



DONE
LOADED
ADVANCE
DRIVE MOTOR
10
11
15
17
21
23
29
30
31
32
33
34
35
36
40
41
43
45
50

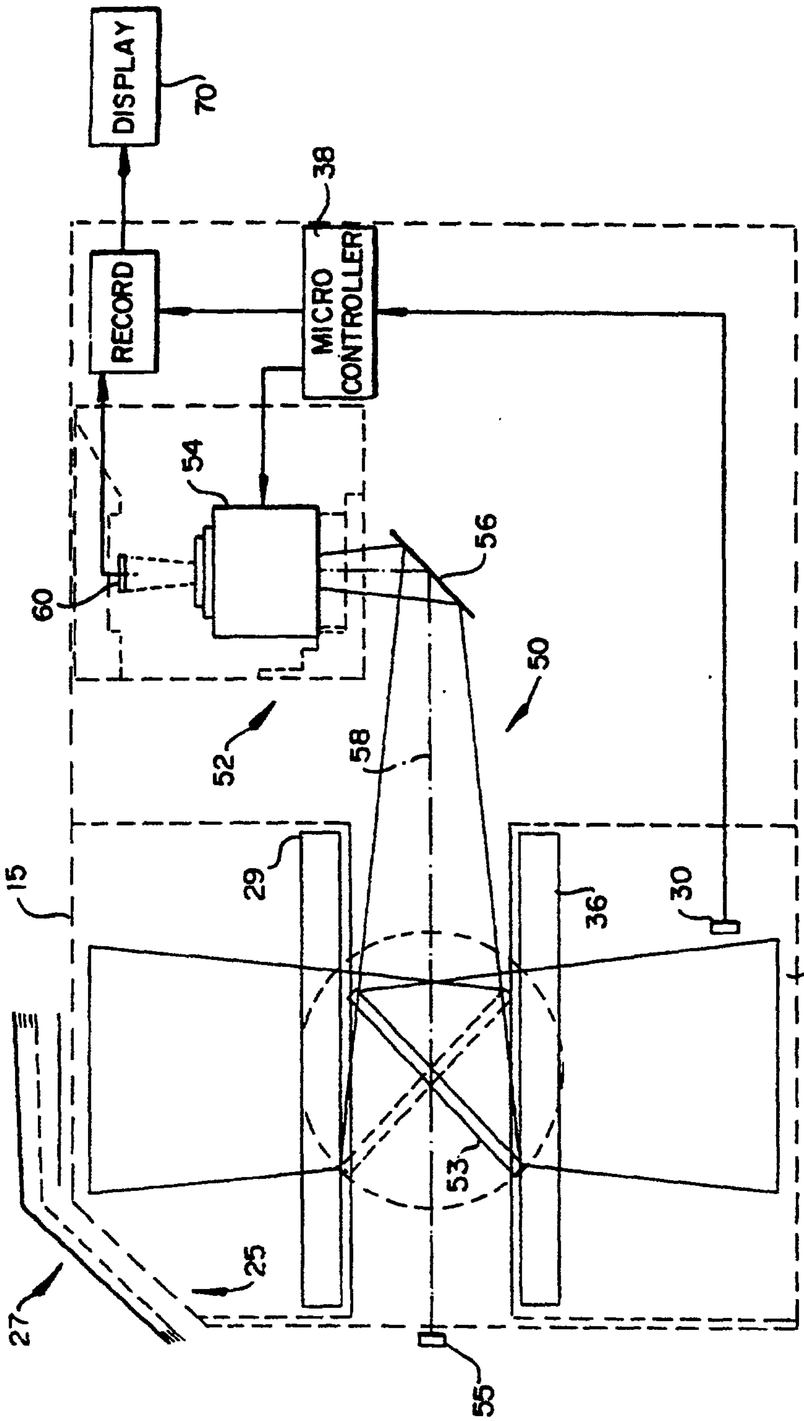

DISPLAY
70
RECORD
MICRO CONTROLLER
38
54
56
60
50
52
58
15
29
36
30
17
53
25
27
55

FIG. 4

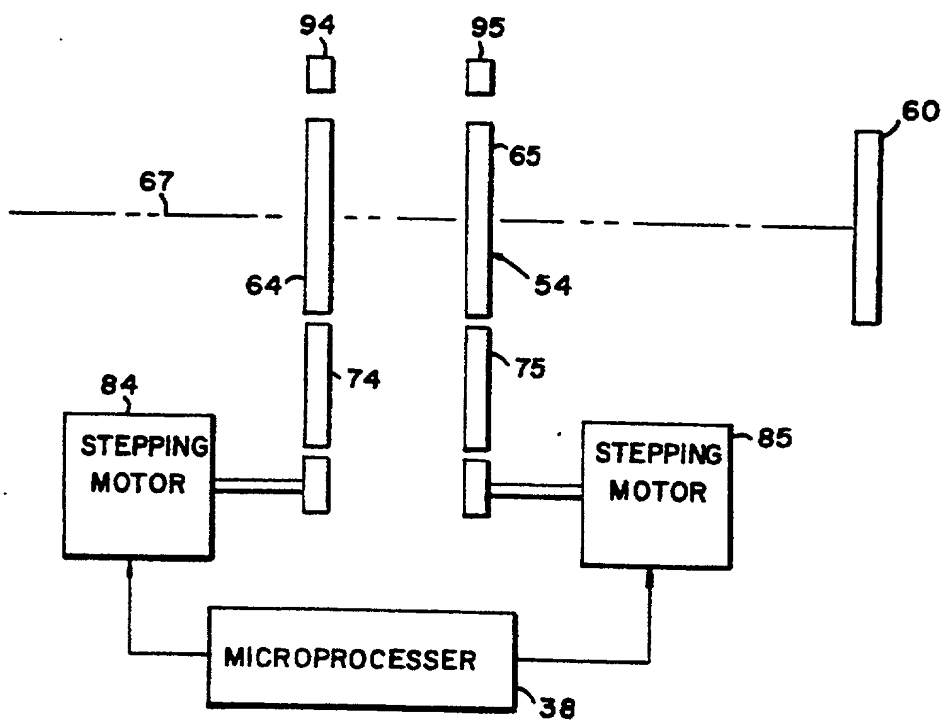
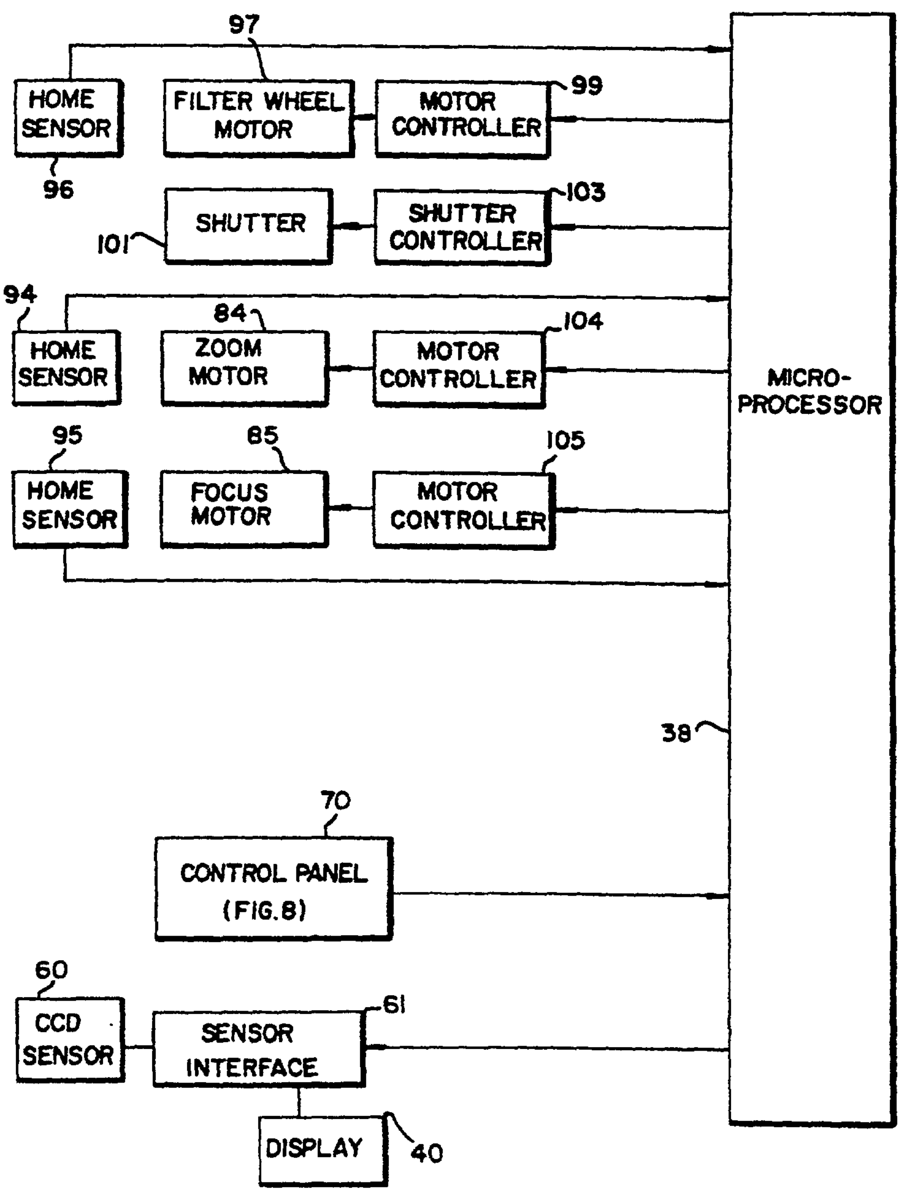

94
95
60
65
67
64
54
74
75
84
STEPPING MOTOR
85
STEPPING MOTOR
MICROPROCESSER
38

FIG. 6

FIG. 7


97
HOME SENSOR
FILTER WHEEL MOTOR
MOTOR CONTROLLER
99
96
SHUTTER
SHUTTER CONTROLLER
103
101
94
84
HOME SENSOR
ZOOM MOTOR
MOTOR CONTROLLER
104
MICRO-PROCESSOR
95
85
105
HOME SENSOR
FOCUS MOTOR
MOTOR CONTROLLER
38
70
CONTROL PANEL (FIG.8)
60
CCD SENSOR
SENSOR INTERFACE
61
DISPLAY
40

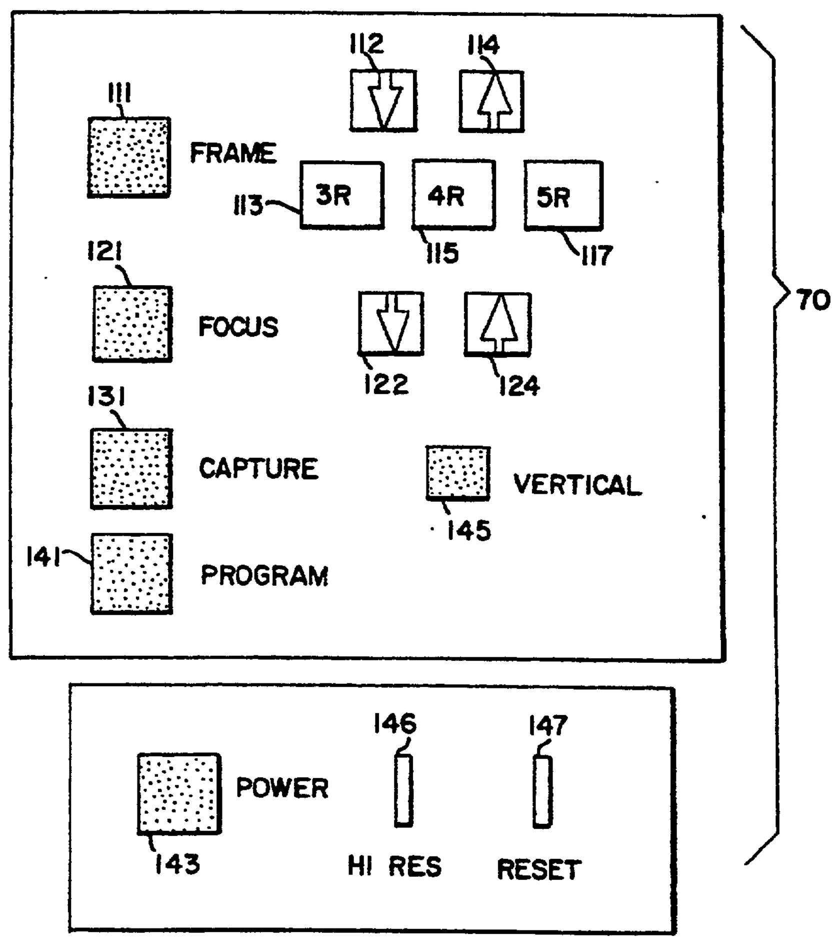

112
114
111
FRAME
113
3R
4R
5R
115
117
121
FOCUS
122
124
70
131
CAPTURE
VERTICAL
145
141
PROGRAM
146
147
POWER
143
HI RES
RESET

FIG. 8

FIG. 9

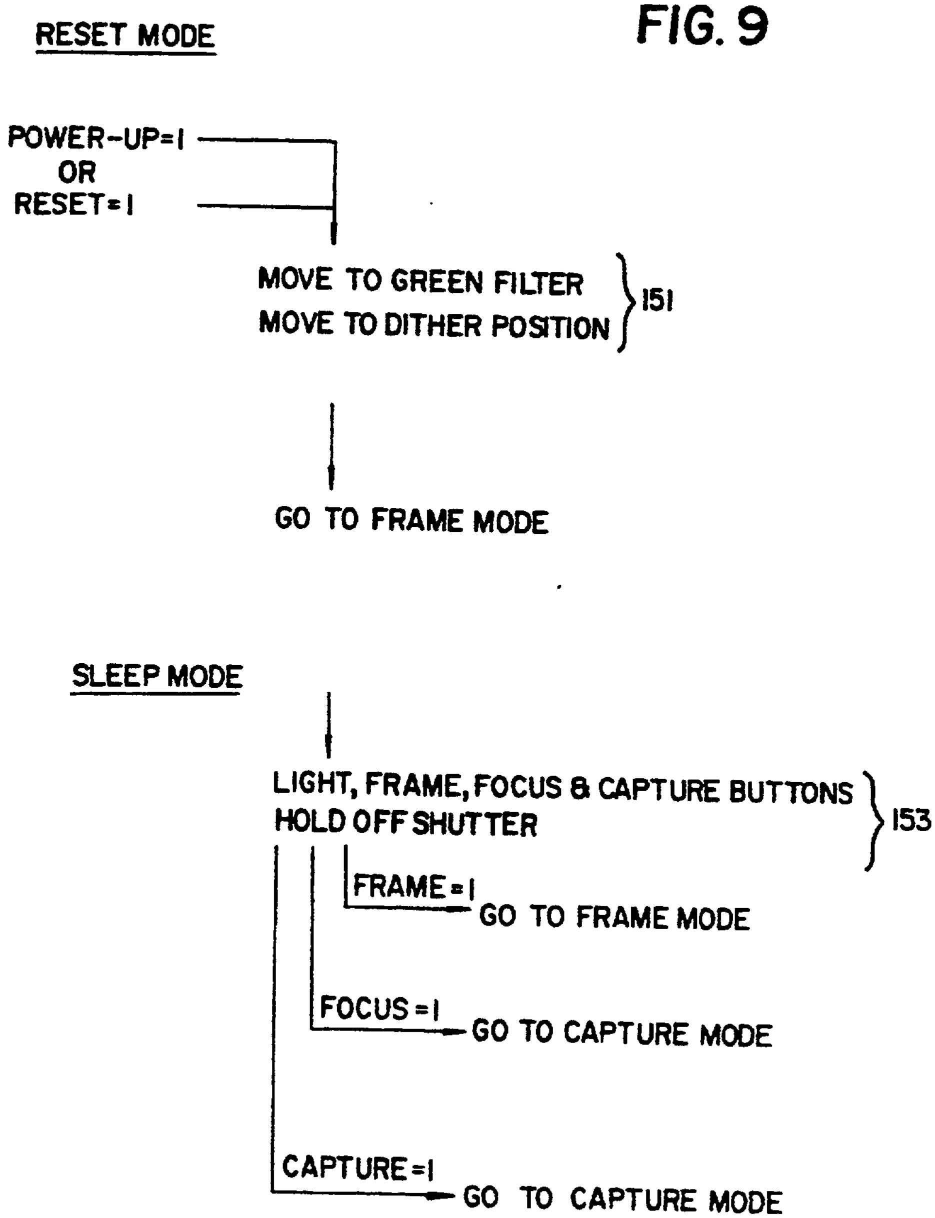
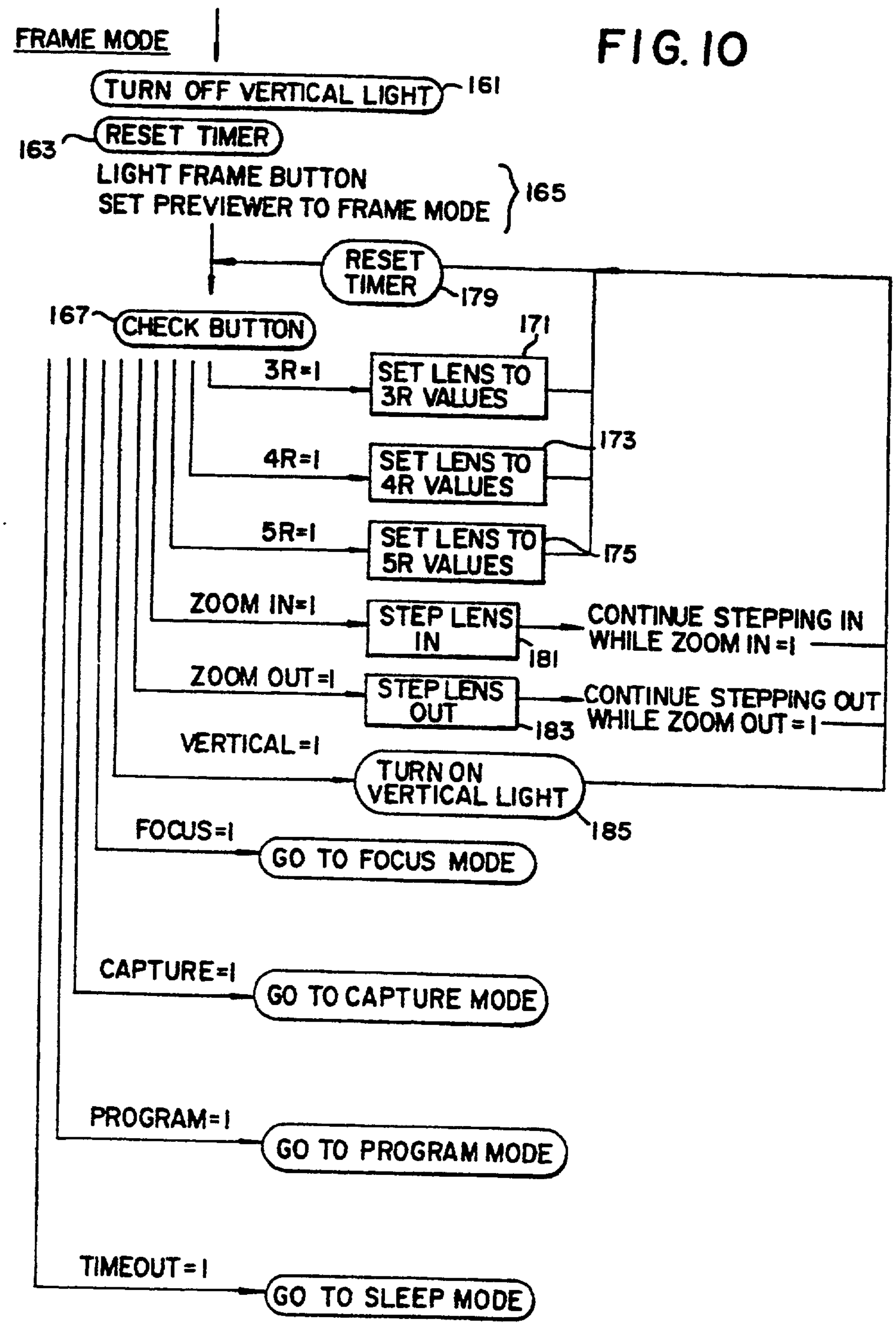

RESET MODE
POWER-UP=1
OR
RESET=1
MOVE TO GREEN FILTER
MOVE TO DITHER POSITION
151
GO TO FRAME MODE
SLEEP MODE
LIGHT, FRAME, FOCUS & CAPTURE BUTTONS
HOLD OFF SHUTTER
153
FRAME=1
GO TO FRAME MODE
FOCUS=1
GO TO CAPTURE MODE
CAPTURE=1
GO TO CAPTURE MODE

FIG. 10


FRAME MODE
TURN OFF VERTICAL LIGHT
161
163
RESET TIMER
LIGHT FRAME BUTTON
SET PREVIEWER TO FRAME MODE
165
RESET TIMER
179
167
CHECK BUTTON
171
3R=1
SET LENS TO 3R VALUES
173
4R=1
SET LENS TO 4R VALUES
5R=1
SET LENS TO 5R VALUES
175
ZOOM IN=1
STEP LENS IN
181
CONTINUE STEPPING IN WHILE ZOOM IN=1
ZOOM OUT=1
STEP LENS OUT
183
CONTINUE STEPPING OUT WHILE ZOOM OUT=1
VERTICAL=1
TURN ON VERTICAL LIGHT
185
FOCUS=1
GO TO FOCUS MODE
CAPTURE=1
GO TO CAPTURE MODE
PROGRAM=1
GO TO PROGRAM MODE
TIMEOUT=1
GO TO SLEEP MODE

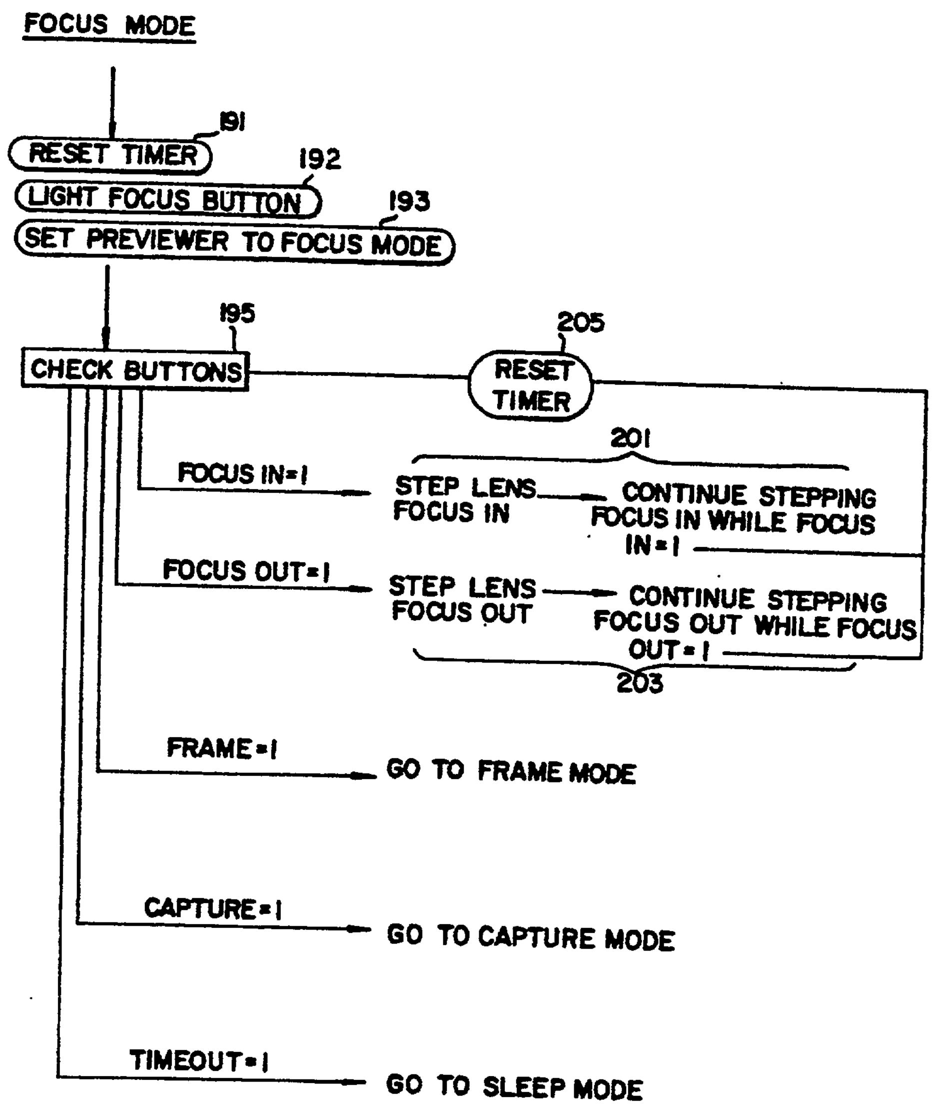

FOCUS MODE
191
RESET TIMER
192
LIGHT FOCUS BUTTON
193
SET PREVIEWER TO FOCUS MODE
195
CHECK BUTTONS
205
RESET TIMER
201
FOCUS IN=1
STEP LENS FOCUS IN
CONTINUE STEPPING FOCUS IN WHILE FOCUS IN=1
FOCUS OUT=1
STEP LENS FOCUS OUT
CONTINUE STEPPING FOCUS OUT WHILE FOCUS OUT=1
203
FRAME=1
GO TO FRAME MODE
CAPTURE=1
GO TO CAPTURE MODE
TIMEOUT=1
GO TO SLEEP MODE

FIG. 11

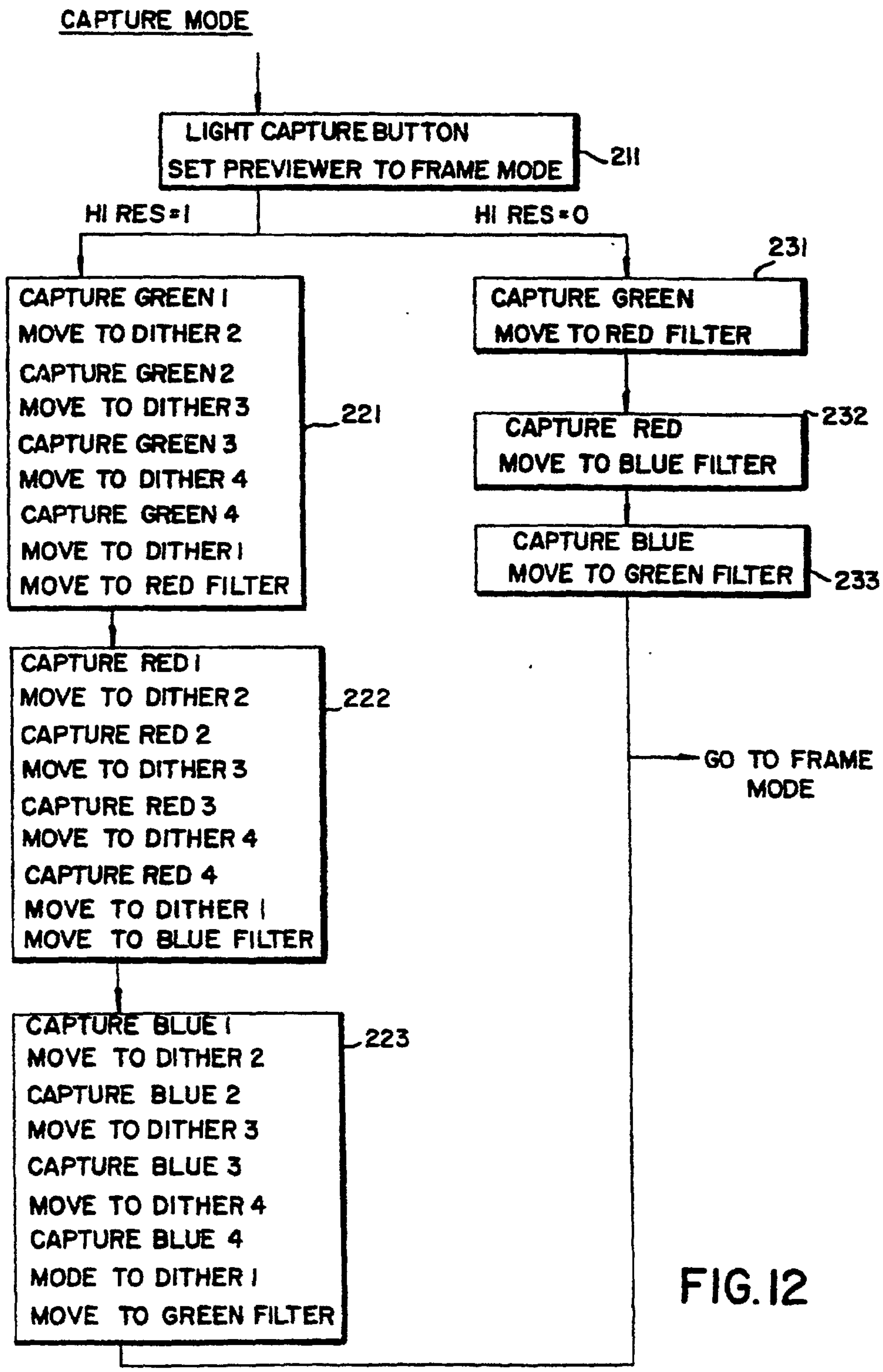

CAPTURE MODE
LIGHT CAPTURE BUTTON
SET PREVIEWER TO FRAME MODE
211
HI RES=1
HI RES=0
CAPTURE GREEN 1
MOVE TO DITHER 2
CAPTURE GREEN 2
MOVE TO DITHER 3
CAPTURE GREEN 3
MOVE TO DITHER 4
CAPTURE GREEN 4
MOVE TO DITHER 1
MOVE TO RED FILTER
221
CAPTURE RED 1
MOVE TO DITHER 2
CAPTURE RED 2
MOVE TO DITHER 3
CAPTURE RED 3
MOVE TO DITHER 4
CAPTURE RED 4
MOVE TO DITHER 1
MOVE TO BLUE FILTER
222
CAPTURE BLUE 1
MOVE TO DITHER 2
CAPTURE BLUE 2
MOVE TO DITHER 3
CAPTURE BLUE 3
MOVE TO DITHER 4
CAPTURE BLUE 4
MODE TO DITHER 1
MOVE TO GREEN FILTER
223
231
CAPTURE GREEN
MOVE TO RED FILTER
CAPTURE RED
MOVE TO BLUE FILTER
232
CAPTURE BLUE
MOVE TO GREEN FILTER
233
GO TO FRAME MODE

FIG. 12

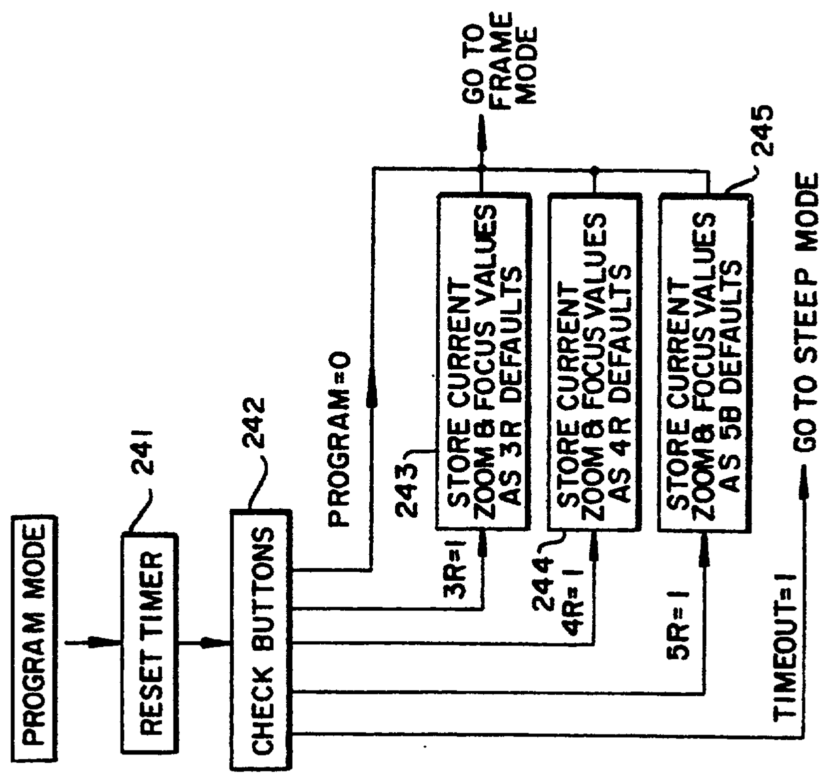

PROGRAM MODE
RESET TIMER
241
CHECK BUTTONS
242
PROGRAM=0
243
STORE CURRENT ZOOM & FOCUS VALUES AS 3R DEFAULTS
3R=1
244
STORE CURRENT ZOOM & FOCUS VALUES AS 4R DEFAULTS
4R=1
STORE CURRENT ZOOM & FOCUS VALUES AS 5B DEFAULTS
5R=1
245
GO TO FRAME MODE
TIMEOUT=1
GO TO STEEP MODE

FIG. 14

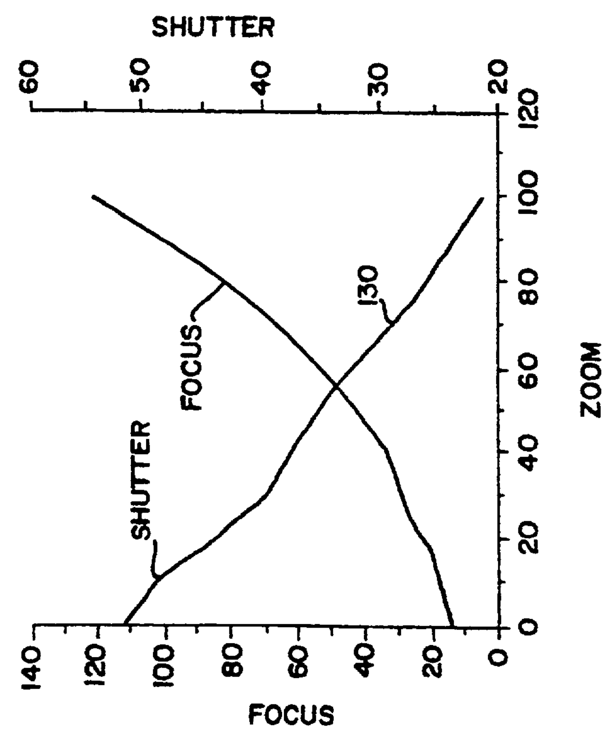

SHUTTER
60
50
40
30
20
FOCUS
SHUTTER
130
140
120
100
80
60
40
20
0
FOCUS
0
20
40
60
80
100
120
ZOOM

FIG. 13

PRINT SCANNER WITH SOFT KEY VARIABLE MAGNIFICATION

FIELD OF THE INVENTION

The present invention relates to a photoprint digitizing scanner having a variable magnification zoom lens, respective magnification and focus settings for which may be changed in order to accommodate different sized photoprints, and is particularly directed to a mechanism for adjusting, storing and retrieving default magnification and focus settings for a zoom lens, so as to facilitate sequential scanning of a plurality of photoprints having similar dimensional characteristics.

BACKGROUND OF THE INVENTION

Recent improvements in their spatial and data resolution capabilities have made digital color image processing systems attractive for a number of photoprocessing (e.g. photo-finishing) applications. In still color image photography, for example, once an image (such as that captured on color photographic film or a high resolution color digital camera) has been digitized and stored in an attendant data base, it is readily optimized for reproduction by means of photofinishing image processing software. Such image processing systems also provide for the storage and retrieval of high resolution digitized color still images for application to a variety of reproduction devices. This not only enables the photofinisher to optimize the quality of a color image print, but allows the images on a processed roll of film to be stored in digital format on a compact disc (CD), which may then be delivered to the customer for playback by a CD player and display on a television set.

One such apparatus is described in co-pending U.S. patent application Ser. No. 582,305, filed Sep. 14, 1990, entitled "Multiresolution Digital Imagery Photofinishing System," by S. Kristy, assigned to the assignee of the present application and the disclosure of which is herein incorporated. As diagrammatically illustrated in FIG. 1, such a digitizing apparatus may employ a high resolution opto-electronic film scanner **12**, the output of which is coupled to a host digitized image processor (host computer) **14**. Scanner **12** typically contains a very high resolution sensor pixel array (e.g. a 3072×2048 pixel matrix) capable of generating high spatial density-representative output signals which, when converted into digital format, yield 'digitized' photographic image files from which high quality color prints may be obtained. Scanner **12** is arranged to be optically coupled with a photographic recording medium, such as a consumer-supplied 35 mm color film strip **16**. Film strip **16** contains a plurality (e.g. a set of twenty-four or thirty-six) 36 mm×24 mm color image frames. For each scanned image frame, high resolution scanner **12** outputs digitally encoded data, representative of the opto-electronic response of its high resolution imaging sensor pixel array, onto which a respective photographic image frame of film strip **16** is projected by the scanner's input lens system.

This digitally encoded data, or 'digitized' image, is supplied in the form of an imaging pixel array-representative bit map, resolved to a prescribed code width (e.g. eight bits per color per pixel), to a host processor **14**. Host processor **14** contains an image encoding and storage operator through which each high resolution digitized image file is stored, preferably in a multi-resolution, hierarchical format. Such a storage format facilitates retrieval of the digitized images for reproduction by a variety of devices the resolution of which may vary from device to device, such as a low/moderate NTSC television monitor or a very high resolution, digitally driven, color thermal printer. The spatial parameters of each of the hierarchical image files into which an original 2K pixel×3K pixel digitized image file is encoded and stored are chosen to facilitate the implementation and incorporation of a low cost, reduced complexity frame store/data retrieval architecture into a variety of reproduction devices, thereby providing for rapid call-up and output (display or print out) of one or more selected images.

In addition to using such improved photofinishing equipment to process current day images, such as capturing original color images in digital format by way of a high resolution digitizing color camera, or scanning a roll of color negative film, there is also the demand for using such digital image processing capability to convert 'old' photographs, such as dated photoprints that have been kept in a loose pile in a 'shoebox', or mounted in a family photo album, into digital format for CD storage, thereby allowing a customer to store and catalog the images on such prints for subsequent television viewing.

In consideration of this need, co-pending U.S. patent application Ser. No. 762,323, filed Sep. 16, 1991, by K. A. Parulski et al, entitled "Dual Imaging Station Scanner", assigned to the assignee of the present application and the disclosure of which is herein incorporated, describes a digitizing scanner apparatus which has the ability to automatically digitize a plurality of photoprint images which the customer brings to the photofinisher in a loosely arrayed pile or mounted in a photo-album binder, thereby allowing a photofinisher to rapidly process any number of pictures provided by the customer, irrespective of the condition or form in which the photoprints are supplied.

More particularly, FIG. 2 is an exterior perspective view, while FIGS. 3 and 4 are diagrammatic respective front and side views of the internal architecture of a dual imaging station, photoprint digitizing scanner described in the above-referenced Parulski et al application. The scanner, which is shown generally at **10**, preferably comprises a housing or cabinet **11**, having an upper, horizontally translatable unit **13**, which supports a large area imaging station **15** for viewing an individual photoprint either by itself or retained on a page of a photo album or the like. Beneath unit **13** (and upper imaging station **15**) is a lower, magazine-fed platen imaging station **17**. Translatable unit **13** is supported for back and forth horizontal movement (or translation) in the direction of arrows A, either manually or by a drive motor (not shown), for the purpose of bringing a desired portion of imaging station **15** into optimum registration with viewing optics through which a photoprint is imaged onto a downstream opto-electronic image sensor.

The upper imaging station **15** comprises a transparent (e.g. glass) plate **21** upon which an individual sheet of photographic recording material, such as a photoprint, **23** may be placed in a face-down condition. Adjacent to top plate **21**, translatable unit **13** has a sloped support surface **25**, thereby providing, in cooperation with top plate **21**, a broad area surface for supporting a large item, such as a photo album (shown diagrammatically in broken lines **27** in its open, face-down condition), so that

a page of the photo album may be easily placed in direct imaging-abutment with top plate 21. A first imaging station illuminator 29 comprised of a rectangular configuration of a set of four fluorescent lamps is located beneath top plate 21, so as to provide effectively even illumination of a sheet or page of recording material that is placed face down on the top plate.

A lower portion of cabinet 11 retains a platen feed mechanism 31, which is operative to withdraw and translate a photographic print support platen from a first platen supply magazine 32 to a platen imaging station 17, and then feed the platen from the platen imaging station to a second take up platen storage magazine 34. An individual platen is preferably of a type detailed in co-pending U.S. patent application Ser. No. 760,437, filed Sep. 16, 1991, entitled "Photoprint Retaining Platen For Digitizing Image Scanner", by K. A. Parulski et al, assigned to the assignee of the present application and the disclosure of which is herein incorporated.

A photoprint-support platen as described in that application may be generally configured as diagrammatically illustrated at 18 in FIG. 5, to facilitate presentation of a photoprint to an imaging station of a photoprint imaging scanner, in a secure protected condition, while also allowing a plurality of photoprint platens to be arranged in a stacked configuration and fed one at the time to a platen imaging station, and then fed from the platen imaging station to a take up location. Preferably, a photoprint support- platen includes a photoprint-retention or mounting surface area 19 which contains a semi-tacky material 20 for removably securing a photoprint to the platen, so that the platen may be re-used with other photoprints. Adjacent to the mounting surface area are side rails 22 and the ends 26 of the platen are sloped or beveled to facilitate interleaving of multiple platens in a stack, without the mounted photoprints being contacted by an adjacent platen. One or more image parameter regions 28 are located adjacent to a photoprint mounting surface area for storing machine readable photoprint parameter information (e.g. bar codes or adjustable indicator elements). This machine readable information is detected by one or more image parameter sensors 30 located in the feed path of platen imaging station 17. The outputs of these sensors are coupled to a microcontroller 38, such as an Intel 80C196KB microcontroller which controls the operation of the scanner, including the imaging optics, to rapidly project and focus the image on the photoprint onto an opto-electronic image sensor (e.g. a high resolution CCD image sensor) 60.

The platen feed mechanism comprises a set of controllably driven pinch rollers 41 located between magazine 32 and platen imaging station 17, and a set of controllably driven pinch rollers 43 located between platen imaging station 17 and magazine 34. A controllably stepped drive motor 45 is coupled to rollers 41 and 43 by means of a conventional pulley/drive belt arrangement, not shown, and is controllably driven by the system microcontroller to rotate the pinch rollers and thereby sequentially extract a platen from a bottom slot 33 of supply magazine 32, translate an extracted platen to imaging station 17 and then translate the platen from imaging station 17 to a lower entry slot 35 of take up storage magazine 34. A second imaging station illuminator 36 comprised of a rectangular configuration of a set of four fluorescent lamps, similar to that of illuminator 29 for the first imaging station 15, is located directly above platen imaging station 17, so as to provide effectively even illumination of an individual photoprint carried by a platen that has been transported to imaging station 17.

Supported within housing 11 between upper and lower imaging stations 15 and 17 is a multi-directional image projection mechanism 50. Image projection mechanism 50 is operable to selectively project the image of a photoprint at a selected one of imaging stations 15, 17 onto an opto-electronic image sensor 60, such as a high resolution CCD sensor, the 1536×1024 pixel array of which is electronically scanned and digitized to obtain a digitized image, which is stored in an attendant framestore for subsequent processing. Because the sizes of photoprints may vary (typically 3R, 4R and 5R sized prints) image projection mechanism 50 includes a magnification/focussing unit 52, preferably an adjustable focus zoom lens 54, so that the photoprint image that is projected on the high resolution sensor 60 may be adjusted, as necessary, to ensure that the digitized image that is written onto a compact disc and played back on a customer's home CD player will be correctly displayed, in focus and filling the screen of a customer's television set.

Now although professional photofinishers employ standardized photoprint sizes, such as the above- mentioned 3R, 4R and 5R sizes, in practice, the actual dimensions of batches of photoprints produced by different photofinishers may vary from one another (e.g. by as much as one-quarter an inch per edge). As a result, employing a fixed magnification default setting for the zoom lens for a given photoprint size will not necessarily guarantee that the photoprint will be properly imaged on the scanner's photosensor. In order to accommodate variations in photoprint dimensions, the zoom lens is adjustable by the photofinisher, who observes the image by way of an auxiliary, relatively low resolution, monochromatic 'preview' display unit to which the output of the scanner's image sensor is coupled. When the photofinisher is satisfied that the image is properly sized (and focussed) within the confines of the preview display screen, scanning and digitizing of the photoprint image as projected onto the image sensor is invoked.

A shortcoming of such photofinisher participation in the scanning of each photoprint is the fact that the preview operation is time consuming and labor intensive, and thereby results in an increased cost per processed print image. Ideally, the zoom lens magnification should be controlled by way of default settings associated with each photoprint size. Unfortunately, however, as noted above, different photoprints of a given size (e.g. 3R) do not necessarily have the same dimensions.

SUMMARY OF THE INVENTION

In accordance with the present invention, the need for the photofinisher to perform a zoom lens adjustment for each photoprint of a given batch of photoprints is obviated by a lens control mechanism through which default settings for zoom lens magnification and focus may be calibrated, as necessary, as a precursor step for processing a plurality of photoprints belonging to a common batch. In particular, the present invention is directed to a lens control mechanism in which, for a given print size, the magnification and focus default settings of the projection system's zoom lens may be readily recalibrated to new values associated with magnification and focus adjustments of the zoom lens through which the photofinisher has optimized the

presentation of the photoprint image on a preview display monitor to which the output of the scanner's image sensor is coupled. Thereafter, as additional photoprints of the same size of that batch are processed, the reprogrammed default settings are used without the need for adjustment, so that each photoprint will be properly imaged on the scanner's photosensor.

The lens control mechanism of the present invention is especially useful for automatically scanning a series of platen-mounted photoprints, the platens for which contain machine readable photoprint parameter information (e.g. bar codes or adjustable indicator elements), as described above. As such machine readable information is detected by one or more image parameter sensors located in the platen feed path, the magnification and focus default settings are used to rapidly adjust the image projection system, including zoom and focussing ring positions of the zoom lens, so as to facilitate the automatic processing of a plurality of photoprints of a common batch.

More particularly, the image magnification control mechanism in accordance with the present invention is intended for use with an apparatus, such as the above refe-:nced scanner, which is operative to digitize an image that has been recorded on a photographic recording medium, such as 35 mm film, and stores the digitized image on a digital storage medium, such as an optical compact disc. As noted above, within the projection path of the scanner is an image projection device containing a variable magnification device in the form of an adjustable focus, zoom lens. The projection path is incident upon a photo-responsive device, such as a high resolution CCD sensor, image outputs signals from which are digitized for storage on a compact disc. Control of the operation of the scanner includes the use of a display device to which output signals provided by the photosensor are coupled so as to display the projected image.

Whenever a photoprint is presented to the scanner an indication of the size of the photoprint is provided, as by way of a code stored on a photoprint platen, in order to set the magnification setting of the zoom lens. The photofinisher observes the display of the image projected on the photosensor and adjusts, as necessary, the operation of the zoom lens so that the image displayed by the display device fits the display screen. Using a program feature of a user interface, the photofinisher stores in memory information representative of the adjustment of the zoom lens. Then, for subsequent presentations of photoprints to the scanner, the stored adjustment information is used as a magnification setting default value for a respective photoprint size. Whenever the magnification of the zoom lens is adjusted, there is an accompanying change in the focus ring of the lens, so that the displayed image is maintained in focus, and substantially fills the display area of the display device. To capture a high resolution image (four times that of the resolution of the image sensor), an optical translation dither device is provided which controllably varies the spatial location at which an image projected by the zoom lens device is incident upon the image sensor. A color filter mechanism which contains a plurality of respectively different color filters is rotated so that the filters are sequentially inserted in the path of the projected photoprint image, so that successively selected color components of the projected image are captured, digitized and stored. For those images which have been captured with a camera rotated ninety degrees (vertical images), the user interface includes a vertical button which, when depressed, causes the controller to store information representative of the vertical orientation of the image on the photoprint. This 'vertical' code is stored in a control file on the compact disc so that the image will be displayed upright on playback.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 diagrammatically shows a photo digitizing apparatus described in co-pending U.S. patent application Ser. No. 582,305, filed Sep. 14, 1990, entitled "Multiresolution Digital Imagery Photofinishing System," by S. Kristy;

FIG. 2 is an exterior perspective view, while FIGS. 3 and 4 are diagrammatic respective front and side views of the internal architecture of a dual imaging station, photoprint digitizing scanner described in the above-referenced Parulski et al application;

FIG. 5 diagrammatically shows a photoprint-support platen used to feed a photoprint to an imaging station of a photoprint imaging scanner;

FIG. 6 diagrammatically shows a zoom lens fitted with magnification and focus adjustment rings;

FIG. 7 is a lens control system diagram of FIG. 7;

FIG. 8 shows a scanner user interface in the form of a set of control buttons;

FIG. 9 shows RESET MODE and SLEEP MODE routines of the control mechanism of the invention;

FIG. 10 shows the operational flow through the FRAME mode routine of the control mechanism of the invention;

FIG. 11 shows the operational flow through the FOCUS mode routine of the control mechanism of the invention;

FIG. 12 shows the operational flow through the CAPTURE mode routine of the control mechanism of the invention;

FIG. 13 shows such an empirically determined characteristic stored in a focus adjustment look-up table for adjusting the focus of the zoom lens as its magnification setting is changed; and

FIG. 14 shows the operational flow through the PROGRAM mode routine of the control mechanism of the invention.

DETAILED DESCRIPTION

As described previously, the photoprint scanner described in the above-referenced Parulski et al application and illustrated diagrammatically in FIGS. 2, 3 and 4, includes a multi-directional image projection mechanism 50, which is operable to controllably project the image of a photoprint, that has been placed or positioned at a selected one of imaging stations 15, 17, onto a high resolution image sensor 60. Because the sizes of photoprints may vary, image projection mechanism 50 includes an adjustable magnification/focussing unit 52 that preferably contains an adjustable focus zoom lens 54, such as a Nikon 35-70 mm zoom lens.

Zoom lens 54 is shown diagrammatically in FIG. 6 as being fitted with magnification and focus adjustment rings in the form of toothed collars 64 and 65, respectively. The collars are mounted so that as they are rotated, they are translated along an image projection axis 67, which intersects (and is normal to) the plane of the scanner's high resolution CCD sensor 60. For this purpose, each lens collar 64 and 65 is coupled either directly or through a suitable linkage (e.g. belt and pulley

coupling) 74, 75 to a respective stepper motor 84, 85. The gear ratio and stepper motor resolution are such as to allow fine angular motion of the zoom lens so as to permit fine adjustments in both its magnification and focus settings. Respective 'home' or 'reset' position sensors 94, 95 are arranged along the travel path of lens collars 64, 65 for detecting when the collars have reached prescribed reference positions on axis 67.

As illustrated in the lens control system diagram of FIG. 7, stepper motors 84, 85 are controllably driven by associated motor controllers 104, 105 under the control of microcontroller 38, in response to either operator-sourced inputs or platen-sourced parameter data, so as to control the size and position of the photoprint image that is projected and focussed on CCD sensor 60. Also shown in FIG. 7 are the control components for a shutter and an associated filter wheel which control the amount of light and color components of photoprint images projected onto sensor 60, as described in co-pending U.S. patent application Ser. No. 575,772, filed Aug. 31, 1990, entitled "Color Sequential Scanner Incorporating A Synchronized Variable Exposure Shutter" by K. A. Parulski et al, assigned to the assignee of the present application and the disclosure of which is herein incorporated.

As described in that application, advantage is taken of the improved color balance properties of fluorescent lamps, by synchronizing the exposure time of an electronic shutter 101 (through which respective red, blue and green color images of a photoprint are sequentially captured by high resolution opto-electronic image sensor 60) with the AC power source for the lamps. By using a high resolution image sensor, such as a 1536×1024 pixel CCD image sensor for image sensor 60, and effecting a two dimensional optical translation of the image sensor relative to the projected image makes it possible to realize a 3072×2048 pixel (high resolution) image corresponding to that obtained by the image pixel matrix of a high resolution image color image camera. Such a relative dither may be accomplished by either physically translating the image sensor itself or by translating the projected image.

In accordance with a preferred embodiment of the scanner, the projected image is 'dithered' in the X and Y directions on the image plane of CCD sensor 60 by means of an image dither mechanism in the form of a canted glass plate, which is inserted in the image projection path ahead of sensor 60 and sequentially rotated in ninety degree segments so as to cause successively projected images to fall on (four) respectively adjacent regions of the sensor. Capturing and digitizing the image that falls on each of these adjacent regions makes it possible to realize a 3072×2048 high resolution image output from the CCD image sensor.

For each respective monochromatic image (one of red, green and blue) as determined by a sequentially stepped color filter wheel shown at 97, the output of image sensor 60 is digitized and stored in an associated image framestore of host processor/microcontroller 38. The stored digitized image is then processed by the host image processor for storage on a digital storage medium, such as a compact disc, which may then be delivered to the customer for playback by a CD player and display on a home television set.

Specifically, a multicolor filter wheel 97 is controllably rotated by a motor controller 99 to sequentially insert a respective one of successive red, green and blue filters in the path of the projected image, while the operation of a shutter 101 is controlled by a shutter controller 103 to define the length of time that the photoprint is imaged on sensor 60. Like zoom stepper motor 84 and focus stepper motor 85, filter wheel motor 97 has an associated home or reset sensor 96 which establishes a reference or reset position for the filter. As a non-limitative example, filter wheel 97 may have a home position such that its green filter is disposed in the path of the projected image. This home color is used during the preview display of the photoprint image.

The photoprint image that is focussed on sensor 60 is read out through a sensor interface 61 to microcontroller 38 and to a 'preview' display monitor 40. By observing this 'preview' display, the photofinisher is able to adjust as necessary, via a set of control buttons on a control panel 70 and described below with reference to FIG. 8, the control parameters of image magnification/focussing unit 52, until the previewed image is optimally focussed and geometrically positioned on the display screen. As will be described, when the photofinisher is satisfied that the image is properly displayed, he may depress a 'program' button, which causes the magnification and focus settings for a selected print size to be stored in a default table, so that the control parameters for the zoom lens will be effectively calibrated to that photoprint. Thereafter, for subsequently fed platen-mounted photoprints, the operation of the image magnification/focussing unit is automatically referenced to the newly calibrated default settings, thereby facilitating rapid scanning of a series of platen-mounted photoprints.

As explained above, in order to enable the photofinisher to optimally adjust the projection and focussing parameters of the scanner, such as any required translation of unit 13 and adjustment of zoom lens 54, the output of high resolution CCD image sensor 60 is coupled separately of the high resolution image processing workstation to an auxiliary, lower resolution, monochromatic 'preview' display unit 40. While it is possible to use the high resolution color display terminal of the photofinishing workstation for this purpose, from a practical operational standpoint, the processing time required to display the full color 3072×2048 pixel image is prohibitive. For successful operation of the scanner, what is necessary is that, prior to image capture, the photoprint be correctly positioned, and its image correctly sized and focussed on the image sensor. To satisfy these requirements, during a 'preview' of the image, the photofinisher does not need to view a full color image at its highest resolution; a lower resolution, monochromatic image will do.

In accordance with a preferred embodiment of the invention, in order to rapidly preview what is seen by the CCD image sensor 60 on display 40, sensor output interface 61 preferably includes an auxiliary preview framestore apparatus of the type described in U.S. Pat. No. 5,138,454 entitled "Megapixel Video Previewer Framestore and Display", by K. A. Parulski et al, assigned to the assignee of the present application and the disclosure of which is herein incorporated. As described in that application, the auxiliary preview framestore apparatus includes a pair of 'ping-pong' write/-read memories, the pixel and line rate clocks to the address generators of which are multiplexed, so as to not only permit rapid display of a low resolution version of the photoprint image, but to display the image in a variety of formats for optimizing the manner in which the photoprint may be digitized and stored.

Referring now to FIG. 8, a diagrammatic illustration of a user interface mounted on a control panel of the scanner and employed by the photofinisher to adjust photoprint image magnification and focus is shown as comprising a set of control buttons 70. Control buttons 70 are coupled to microcontroller 38 via an input interface to supply user requests which are serviced as interrupts for controlling the operation of the system. As shown in FIG. 8, the control buttons include four mode buttons 111, 121, 131, 141, respectively denoted FRAME, FOCUS, CAPTURE and PROGRAM, through which respective modes of operation of the scanner are initiated.

Associated with the FRAME mode button 111 is a zoom- in button 112, a zoom-out button 114, a set of size buttons 113, 115, 117, respectively associated with prescribed photoprint sizes—3R, 4R and 5R. When the zoom-in button is depressed during FRAME mode, zoom lens 54 is stepwise displaced to increase the magnification of the image projected on image sensor 60 and displayed on 'preview' monitor 40. Conversely, when the zoom-out button is depressed during FRAME mode, zoom lens 54 is stepwise displaced to decreased the magnification of the image. When any of the size buttons 113, 115, 117 is depressed during FRAME mode, zoom lens 54 is displaced in accordance with a default magnification value for the corresponding photoprint size.

Associated with the FOCUS mode button 121 are a focus-in button 122 and a focus-out button 124. When the focus-in button 122 is depressed during FOCUS mode, the focus ring of zoom lens 54 is stepwise displaced in a first direction. Conversely, when the focus-out button 124 is depressed during FOCUS FRAME mode, the focus ring of zoom lens 54 is stepwise displaced in a second, opposite direction.

When the CAPTURE mode is invoked by depressing button 131, filter wheel motor 97 and shutter 101 are operated so as to capture a color high resolution image projected onto photosensor 60. When the PROGRAM mode button 141 is depressed, current settings for the focus and zoom rings of zoom lens 54 are stored as default values for a selected one of size buttons 113, 115, 117.

Also shown in FIG. 8 is a VERTICAL button 145. Depressing this button provides an indication to the microcontroller that the image on the photoprint has a vertical, rather than a conventional horizontal, orientation. This indication is used by the downstream CD recording system to store, as part of an image control file on the disc, a code representative of the fact that the image has a vertical orientation so that on playback it will be displayed upright.

The scanner's user interface also includes an on/off switch, or POWER button 143, a HI RES button 146 used to select whether or not the image is to be captured as a high resolution (HI RES=1) or a low resolution (HI RES=0) image, and a RESET button 147, which resets the system. (RESET=1).

As described above, control buttons 70 are employed by the system operator (photofinisher) to supply user requests which are serviced as interrupts for controlling the operation of the system. The application program employed by microcontroller 38 to initiate service for any pushbutton request contains a module or interrupt service routine denoted as hsio_isr(). In the description to follow, the sequence of operations carried out by this embedded control mechanism will be described with reference to FIGS. 9-14, which show flow among the respective modes of operation of the system, all of which may be invoked manually by the operator and some of which are invocable automatically in accordance with photoprint image parameter information contained on one or more machine readable regions on a platen.

RESET AND SLEEP MODES (FIG. 9)

As shown in FIG. 9, which depicts both RESET MODE and SLEEP MODE routines, upon system power up or reset, a first STEP 151 is performed, whereby various components of the scanner assume prescribed home or reset conditions, including the placement of filter wheel 97 to a 'green' position that inserts the green filter into the projected image path, and the movement of the dither mechanism to a first of its four possible orientations, denoted dither position 1. The routine then proceeds to FRAME MODE, shown in FIG. 10.

Also shown in FIG. 9 is a SLEEP MODE, which is used to inhibit the generation of pulse signals for sensor operation. If a prescribed period of time elapses without the operator pushing one of the buttons on the control panel, this mode is invoked and the FRAME, FOCUS AND CAPTURE buttons are illuminated; in addition the shutter is placed in its closed position, as shown in STEP 153. The system remains in the SLEEP mode until one of the buttons is pushed (=1), whereupon the routine proceeds to the mode associated with that button.

FRAME MODE (FIG. 10)

FIG. 10 shows the operational flow through the FRAME mode, which is the basic routine through which the scanner operator adjusts the zoom lens to optimize the photoprint image for capture and digitized storage. When this mode is invoked, as upon system power up (POWER=1), or by pushing the frame button 111 when the system is in SLEEP mode, a light through which vertical button 145 is illuminated is turned off (STEP 161) and a software timer associated with invoking the SLEEP mode is reset (STEP 163). In STEP 165 the FRAME button is illuminated and the preview display is set to a low resolution frame mode for viewing a monochromatic (green filter inserted) photoprint image. The routine then proceeds to determine which, if any of the buttons on the control panel has been pushed.

Typically the photofinisher will initially push one of the size buttons 113, 115, 117 which causes zoom lens 54 to be rapidly translated to whatever 3R magnification default value is currently stored in memory, as denoted by respective STEPs 171, 173 175. When the zoom lens has been moved to the selected default magnification position, the softimer is reset (STEP 179) and the routine proceeds again to STEP 167.

For purposes of the present description it will be assumed that the image on the preview display requires magnification adjustment. In this case, the scanner operator pushes zoom-in, zoom-out buttons 112, 114, as necessary, to cause zoom lens stepper motor 84 to incrementally adjust the position of zoom lens 54 (STEPS 181, 183). Thus, through the operation of the size and zoom adjust buttons, the operator controls the degree of magnification of the projected and displayed image.

Whenever the setting of the zoom lens is changed, an adjustment of the focus ring is required in order to

maintain the image in focus on image sensor 60. The focus adjustment required is an approximately linear function of the zoom lens setting and may be derived empirically. FIG. 13 shows such an empirically determined characteristic 130, which is preferably stored in a focus adjustment look-up table and is used by microcontroller 38 to adjust the focus of the zoom lens as its magnification setting is changed.

If the image on the photoprint was captured with the camera rotated 90 degrees (vertically oriented), the operator pushes VERTICAL button 145, causing that button to be illuminated (STEP 185), so that microcontroller will store a code representative of the fact that the image has a vertical orientation, to ensure correct orientation on playback, as explained previously.

FOCUS MODE (FIG. 11)

To control the focus, the scanner operator pushes the FOCUS button 121 (FOCUS=1), causing the FOCUS mode routine of FIG. 11 to be invoked. Again, the software timer is reset (STEP 191), the FOCUS button 121 is illuminated (STEP 192) and STEP 193 causes a control signal to be coupled to the above-referenced auxiliary preview framestore apparatus. This control signal is used to modify the frame store read out operation, so that only a prescribed region (a center portion) of the preview display to be updated as the focus is changed.

As in the FRAME mode, in STEP 195, the FOCUS mode routine determines which of focus-in or focus-out buttons 122, 124 has been pushed. In response to whatever of these buttons is pushed by the photofinisher (STEPS 201, 203), focussing ring 65 will be stepwise adjusted each time the button is depressed. After focus adjustment, the routine proceeds to reset the software timer (STEP 205) and returns to STEP 195.

CAPTURE MODE (FIG. 12)

Next, it will be assumed that the scanner operator pushes the CAPTURE button 131 (CAPTURE=1), so that the operation proceeds to the CAPTURE mode routine shown in FIG. 12. In the initial STEP 211, the CAPTURE mode button 131 is illuminated and a control signal is coupled to the auxiliary preview framestore apparatus, to place the preview display in the frame mode, described previously. When the HIGH RESOLUTION button 146 has been depressed (HI RES=1), the image capture routine stepwise rotates the dither plate through all four positions for each of the green, red and blue color components, as shown in STEPs 221, 222 and 223, so as to image three successive high resolution images of the photoprint, each of a respectively different color, on sensor 60. For low resolution image capture (the HIGH RESOLUTION button 146 has not been depressed (HI RES=0)), the dither plate is not stepped through its four positions. Instead, the filter wheel is rotated through each of the green, red and blue color components, as shown in STEPs 231, 232 and 233, so as to image three successive low resolution images of the photoprint, each of a respectively different color, on sensor 60. Upon completion of image capture, either of Steps 223 or 233, the routine proceeds to FRAME mode (FIG. 10).

Depending upon which color filter is placed in the path of the projected image by the stepwise operation of color wheel 97, the amount of light incident on the sensor array will vary, so that the shutter speed must be varied accordingly. For this purpose, preset shutter speed values associated with the respective filter colors, are employed. Shutter speed is also dependent upon the magnification setting of the zoom lens. To accommodate these dependency variations a shutter speed look-up table, such as shown in FIG. 13, may be empirically developed and stored in memory. Then during image capture, the shutter speed for a particular filter wheel color is modified in accordance with the look-up table value for the magnification setting of the zoom lens.

PROGRAM MODE (FIG. 14)

As pointed out previously, a particularly useful feature of the present invention is its default setting adjustability, which significantly reduces the workload on the photofinisher by obviating his need to perform a zoom lens adjustment for each photoprint of a given batch of photoprints. Adjusting the default setting of the zoom lens is readily accomplished by means of PROGRAM button 141 which initiates the PROGRAM routine shown in FIG. 14.

When the scanner operator (photofinisher) pushes the PROGRAM button 141 (PROGRAM=1), in either the FOCUS mode or the FRAME mode, the software timer is reset (STEP 241). The routine then proceeds to STEP 242 to check which of the size buttons 113, 115, 117 has been pushed, indicating for which photoprint size, the current default values for the magnification and focus settings are to be replaced. For the selected photoprint size (e.g. 3R=1), its zoom lens default values are replaced, in one of STEPS 243, 244, 245, by those values which represent the positions of the zoom and focus rings as adjusted by the photofinisher by operation of the zoom-in, zoom-out, focus-in and focus-out buttons, as described above for the FRAME and FOCUS modes. Once the new default values have been stored, the routine proceeds to the FRAME mode. (For each of the FRAME, FOCUS, and PROGRAM modes, if no lens adjustment button or size button is pressed by the scanner operator within the period of the prescribed time out, the TIMEOUT bit will be set to a value of "1", thereby invoking the SLEEP mode, described previously.

While adjustment of the image projection optics may be carried out for photoprints positioned at either the upper imaging station or the platen feed station, its principal benefit is obtained for platen-mounted photoprints which are fed to the platen feed station, where image parameter data codes on the platens are read by the microcontroller for automatic magnification control. Where the photoprint is placed in a face-down condition on top plate 21, the translatable unit 13 is positioned as necessary to locate upper imaging station 15 such that the photoprint is transported to an optimum viewing position, as displayed by 'preview' display 40. The operator then controls the image magnification/focussing unit 52 until the displayed image of the photoprint is satisfactory. The image is then scanned by scanning unit 60, and the resulting digitized high resolution color image of the photoprint is stored in an attendant framestore.

On the other hand, platen imaging station 17 is used to automatically digitize a plurality of photoprints that are mounted to respective ones of a stack of platens fed in sequence from a supply magazine 32. As each platen is fed to the platen imaging station, the image parameter data, such as photoprint size (e.g. 3R, 4R, 5R), contained in machine readable regions on the platens is

detected by one or more image parameter sensors and coupled to microcontroller 38.

On the basis of this image parameter data, microcontroller 38 controls adjustable image magnification unit 54, so as to adjust the size and focus of the image in accordance on the photoprint that is projected onto image sensor 60. The photoprint image that is focussed on the image sensor is, in turn, coupled to the 'preview' display 40. As explained above, by observing the 'preview' display, the photofinisher adjusts as necessary the control parameters of the image magnification/focussing unit, until the previewed image is focussed and correctly geometrically positioned on the display screen. Any adjustment of these control parameters is stored in the default look-up table, so that the control parameters for the image magnification/focussing unit are now effectively calibrated to a particular sized photoprint. Thereafter, for subsequently fed platen-mounted photoprints of that size, the operation of the image magnification/focussing unit projection device is automatically referenced to the newly calibrated parameter settings, thereby facilitating rapid scanning of a series of platen-mounted photoprints.

As will be appreciated from the foregoing description, the need for a photofinisher to perform a zoom lens adjustment of a digitizing scanner for each photoprint of a given batch of photoprints is obviated by a lens control mechanism through which default settings for zoom lens magnification and focus may be calibrated, as necessary, as a precursor step for processing a plurality of photoprints belonging to a common batch. Thereafter, as additional photoprints of the same size of that batch are processed, the reprogrammed default settings are used without the need for adjustment, so that each photoprint will be properly imaged on the scanner's photosensor.

While we have shown and described several embodiments in accordance with the present invention, it is to be understood that the same is not limited thereto but is susceptible to numerous changes and modifications as known to a person skilled in the art, and we therefore do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are obvious to one of ordinary skill in the art.

What is claimed:

1. A method of controlling the operation of an image projection apparatus which is operative to project an image onto an image receiving region, in which a prescribed attribute of said image is adjustable to a plurality of attribute settings, comprising the steps of:

(a) storing respective default values for respective ones of said plurality of attribute settings;

(b) causing said image projection apparatus to project an image onto said image receiving region;

(c) adjusting at least one operational parameter of said image projection apparatus and thereby causing said image projection apparatus to adjust at least one characteristic of the image projected on said image receiving region in step (b); and

(d) storing operational control values employed by said image projection apparatus to project the image adjusted by step (c) as default values for a selected one of said plurality of attribute settings.

2. A method according to claim 1, wherein said prescribed attribute corresponds to the magnification of said image on said image receiving region.

3. A method according to claim 2, wherein step (c) comprises adjusting the magnification of said image by said image projection apparatus.

4. A method according to claim 3, wherein step (c) includes adjusting the focus of said image on said image receiving region.

5. A method according to claim 3, wherein step (c) comprises adjusting, as necessary, the focus of said image with the adjusting of the magnification of said image, so as to maintain the projected image in focus on said image receiving region.

6. A method according to claim 3, wherein step (b) comprises causing said image projection apparatus to project an image onto said image receiving region in accordance with a selected one of said magnification default values.

7. A method according to claim 6, wherein step (c) includes adjusting the focus of the image projected on said image receiving region.

8. A method according to claim 6, wherein step (c) comprises adjusting, as necessary, the focus of said image with the adjusting of the magnification of said image, so as to maintain the projected image in focus on said image receiving region.

9. A method according to claim 1, wherein said projection apparatus further includes an image capture device coupled with said image receiving region and controllably operative to capture an image projected onto said image receiving region, and wherein said method further includes the step of (e) causing said image capture device to capture an image projected onto said image receiving region.

10. A method according to claim 9, wherein step (e) comprises

(e1) causing said image projection apparatus to project said image onto said image receiving region in accordance with the operational control values stored in step (d), and

(e2) causing said image capture device to capture the image projected onto said image receiving device in step (e1).

11. A method according to claim 2, wherein said image projection apparatus includes a zoom lens device through which the magnification of said image on said image receiving region is adjustable and wherein step (c) comprises adjusting said zoom lens device so as to adjust the magnification of said image on said image receiving region.

12. A method according to claim 11, wherein the focus of said zoom lens device is adjustable, and wherein step (c) comprises adjusting, as necessary, the focus of said zoom lens device with the adjustment of the magnification of said image provided thereby, so as to maintain the projected image in focus on said image receiving region.

13. A method according to claim 12, wherein the plurality of default magnification settings of said zoom lens include settings respectively associated with 3R, 4R and 5R photoprint image sizes.

14. A method according to claim 11, wherein said projection apparatus further includes an image capture device coupled with said image receiving region and controllably operative to capture an image projected onto said image receiving region, and wherein said method further includes the step of (e) causing said image capture device to capture an image projected onto said image receiving region by said zoom lens device.

15. A method according to claim 14, wherein step (e) comprises (e1) setting the magnification and focus parameters of the zoom lens device in accordance with default values stored in step (d), and (e2) causing said image capture device to capture the image projected onto said image receiving region by said zoom lens device.

16. A method according to claim 15, wherein said image capture device includes an image sensor and an image storage device coupled thereto, wherein step (e2) includes controllably varying the spatial location at which an image projected by said zoom lens device is incident upon said image sensor and, for each location, storing the incident image in said image storage device.

17. A method according to claim 16, wherein step (e2) comprises storing a selected color component of the projected image and wherein step (e2) is repeated for successively different color components of said image.

18. A method according to claim 17, wherein said apparatus includes a color filter mechanism containing a plurality of respectively different color filters that are sequentially insertable in the path of said projected image, and wherein step (e2) is repeated in association with the insertion of successive ones of said respectively different color filters in the path of said projected image.

19. A method according to claim 18, wherein step (e2) is carried out for respective red, green and blue color components of said image.

20. A method according to claim 9, wherein step (e) includes the step of storing information representative of the orientation of said image on said image receiving region.

21. For use with an apparatus for digitizing an image that has been recorded on a photographic recording medium and storing the digitized image on a digital storage medium, said apparatus including an image projection device and a photo-responsive device upon which an image on said photographic recording medium is projected by said image projection device, said photo-responsive device providing output signals representative of the image projected thereon, said output signals being digitized for storage on said digital storage medium, said apparatus further including a display device to which output signals provided by said photo-responsive device are coupled so as to display the projected image, a method of controlling the operation of said image projection device so as to control the manner in which an image on said photographic recording medium is projected upon said photo-responsive device comprising the steps of:

a) in the course of presenting a photographic recording medium to said apparatus for digitizing the image thereon, providing an indication of the size of the image;

b) causing said image projection device to project an image presented in step (a) upon said photoresponsive device in accordance with the size indication provided in step (a);

c) observing a display of the image projected on said photo-responsive device in accordance with step (c) and adjusting, as necessary, the operation of said image projection device so that the image displayed by said image display device has a prescribed size;

d) storing information representative of the adjustment of the operation of said image projection device in step (c); and

e) for subsequent presentations of photographic recording media to said apparatus in accordance with step (a), causing said image projection device to project an image in step (b) in accordance with the adjustment information stored in step (d).

22. A method according to claim 21, wherein said image projection device comprises an adjustable lens device, and wherein step (c) includes adjusting the operation of said adjustable lens device so that the image displayed by said image display device is displayed in focus on said display device.

23. A method according to claim 21, wherein said image projection device comprises an adjustable focus zoom lens device and wherein step (c) includes adjusting the focus and magnification of said zoom lens device so that the displayed image is displayed in focus and substantially fills the display area of said display device.

24. An apparatus for controlling the projection of an image that has been recorded on a photographic recording medium onto a photoresponsive device, said photoresponsive device providing output signals representative of the image projected thereon, said output signals being coupled to a display device so as to display the projected image, said apparatus comprising:

a controllable magnification, image projection device which is operative to controllably project an image on said photographic recording medium onto said photoresponsive device;

a projection device controller which is operative to control the operation of said image projection device so as to cause said image projection device to project an image on said photographic recording medium onto said photo-responsive device in accordance with information representative of the size of said image as recorded on said photographic recording medium, said projection device controller being operative to adjust, as necessary, the operation of said image projection device so that the image displayed by said image display device has a prescribed size;

a storage device which is controllably operative to store information representative of the adjustment of the operation of said image projection device; and wherein

said projection device controller is coupled to said storage device to access therefrom, for subsequent presentations of photographic recording media to said apparatus, adjustment information stored in said storage device, and to control the operation of said projection device in accordance with said accessed adjustment information.

25. An apparatus according to claim 24, wherein said image projection device comprises an adjustable focus, zoom lens, and wherein said projection device controller is operative to adjust the operation of said zoom adjustable lens so that the image displayed by said image display device is displayed in focus on said display device and substantially fills the display area of said display device.

26. An apparatus according to claim 25, wherein the output of said photo-responsive device is coupled to an image signal digitizing device which is operative to convert said output signals into digital format for storage into a digital image database.

27. An apparatus for controlling the operation of an image projection device which is operative to project an image onto an image receiving region, in which a prescribed attribute of said image is adjustable to a plurality of attribute settings, comprising: a storage device which is operative to store respective default values for respective ones of said plurality of attribute settings;

a projection device controller which is operative to cause said image projection device to project an image onto said image receiving region;

a control mechanism for adjusting at least one operational parameter of said image projection device and thereby causing said image projection device to adjust at least one characteristic of the image projected on said image receiving region; and

wherein said control mechanism is controllably operative to cause said storage device to store operational control values employed by said image projection device to project the adjusted image as default values for a selected one of said plurality of attribute settings.

28. An apparatus according to claim 27, wherein said prescribed attribute corresponds to the magnification of said image on said image receiving region and said projection device controller is operative to adjust the magnification of said image by said image projection device.

29. An apparatus according to claim 28, wherein said projection device controller is operative to adjust the focus of said image, so as to maintain the projected image in focus on said image receiving region.

30. An apparatus according to claim 28, wherein said projection device controller is operative to cause said image projection device to project an image onto said image receiving region in accordance with a selected one of a plurality of magnification default values.

31. An apparatus according to claim 27, further including an image capture device coupled with said image receiving region and controllably operative to capture an image projected onto said image receiving region.

32. An apparatus according to claim 31, wherein said controller is operative to cause said image projection device to project said image onto said image receiving region in accordance with the operational control values stored in said storage device and to cause said image capture device to capture the image projected onto said image receiving device.

33. An apparatus according to claim 28, wherein said image projection device includes a zoom lens through which the magnification of said image on said image receiving region is adjustable and wherein said controller is operative to adjust said zoom lens so as to adjust the magnification of said image on said image receiving region.

34. An apparatus according to claim 33, wherein the focus of said zoom lens is adjustable, and wherein said a controller is operative to adjust, as necessary, the focus of said zoom lens with the adjustment of the magnification of said image provided thereby. so as to maintain the projected image in focus on said image receiving region.

35. An apparatus according to claim 34, wherein the plurality of default magnification settings of said zoom lens include settings respectively associated with 3R, 4R and 5R photoprint image sizes.

36. An apparatus method according to claim 32, further including an image capture device coupled with said image receiving region and which is controllably operative to capture an image projected onto said image receiving region, and wherein said controller is operative to cause said image capture device to capture an image projected on o said image receiving region by said zoom lens, and wherein said controller is operative to set magnification and focus parameters of the zoom lens in accordance with default values stored in said storage device.

37. An apparatus according to claim 36, wherein said image capture device includes an image sensor and an image storage device coupled thereto, and further including a dither device which controllably varies the spatial location at which an image projected by said zoom lens device is incident upon said image sensor, and wherein said controller is operative to cause said image storage device to store, for each location, the incident image.

38. An apparatus according to claim 37, further including a color filter mechanism containing a plurality of respectively different color filters that are sequentially insertable in the path of said projected image, and wherein said controller is operative to cause the insertion of successive ones of said respectively different color filters in the path of said projected image and to cause said image storage device to store successively selected color components of the projected image.

39. An apparatus according to claim 27,

wherein said control mechanism includes means for storing information representative of the orientation of said image on said image receiving region.

* * * * *

18602-06614 : A3

United States Patent [19]

Terashita et al.

[11] 4,364,650

[45] Dec. 21, 1982

[54] EXPOSURE CONTROL METHOD AND DEVICE

[75] Inventors: Takaaki Terashita; Kazuo Shiota; Kenji Nakauchi, all of Minami-ashigara, Japan

[73] Assignee: Fuji Photo Film Co., Ltd., Kanagawa, Japan

[21] Appl. No.: 193,888

[22] Filed: Oct. 3, 1980

[30] Foreign Application Priority Data

Oct. 5, 1979 [JP] Japan 54-128626

[51] Int. Cl.^{3} G03B 7/08

[52] U.S. Cl. .... 354/31; 354/60 R; 250/214 P

[58] Field of Search .... 354/31, 60 R, 23 D; 250/214 P, 209; 356/221, 222; 355/38, 68

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Primary Examiner—William B. Perkey

Attorney, Agent, or Firm—Pasquale A. Razzano

[57] ABSTRACT

A number of light measuring elements are arranged at various portions of an image of an object focused by an objective. The light measuring elements are grouped for different zones to measure the average brightness of the image within the respective zones. The average brightness of the image is weighed and added together to calculate the brightness of the object based on which the exposure is controlled.

3 Claims, 28 Drawing Figures

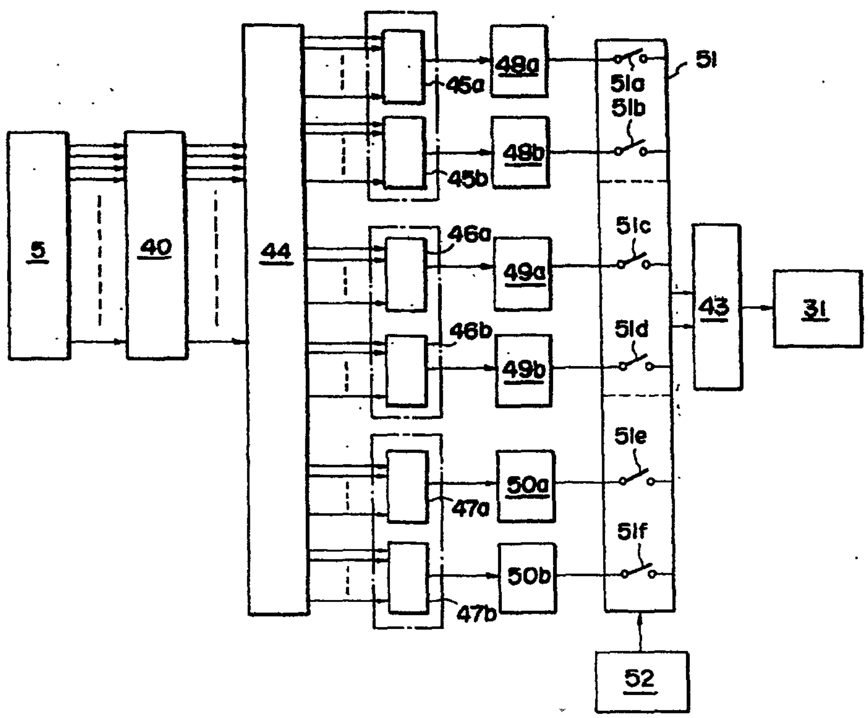


FIG. 1

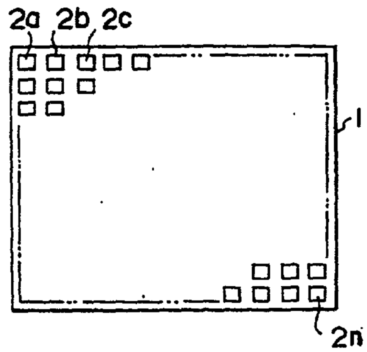


FIG. 2

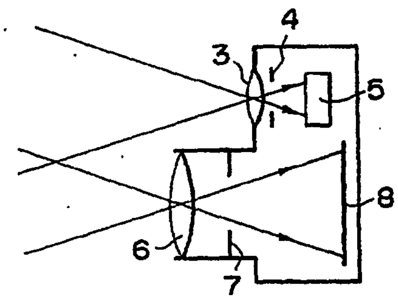


FIG. 3

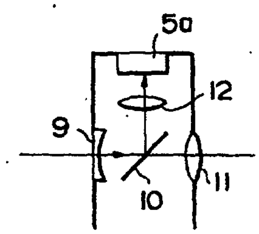


FIG. 4

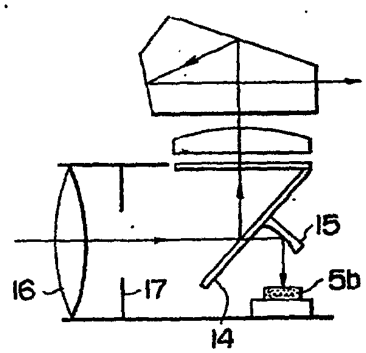


FIG. 5

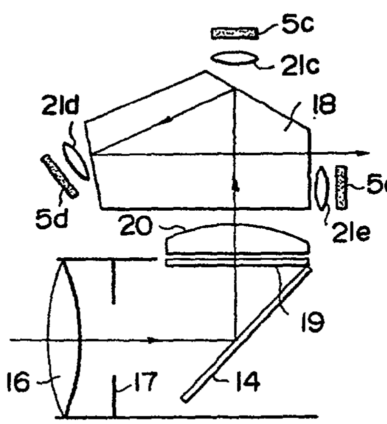


FIG. 6

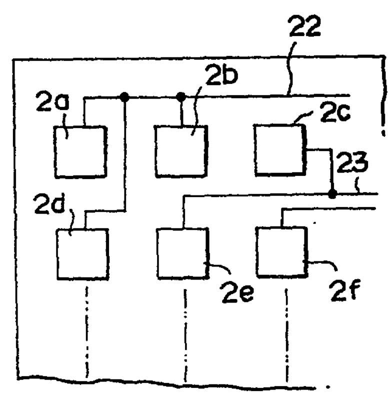


FIG.7A

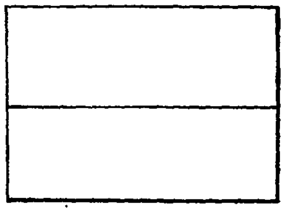


FIG.7B

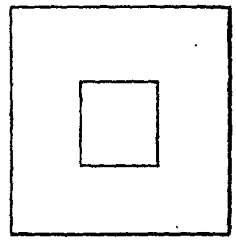


FIG.7C

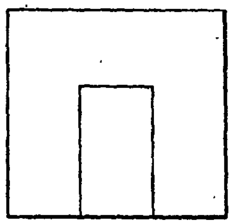


FIG.7D

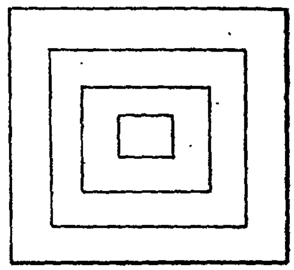


FIG.7E

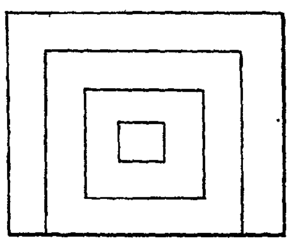


FIG.7F

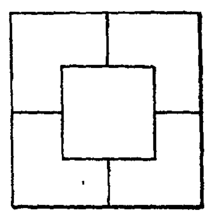


FIG.7G

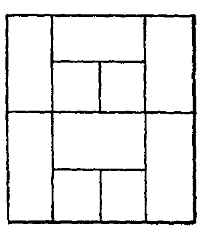
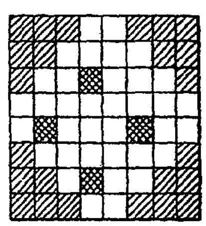


FIG.7H



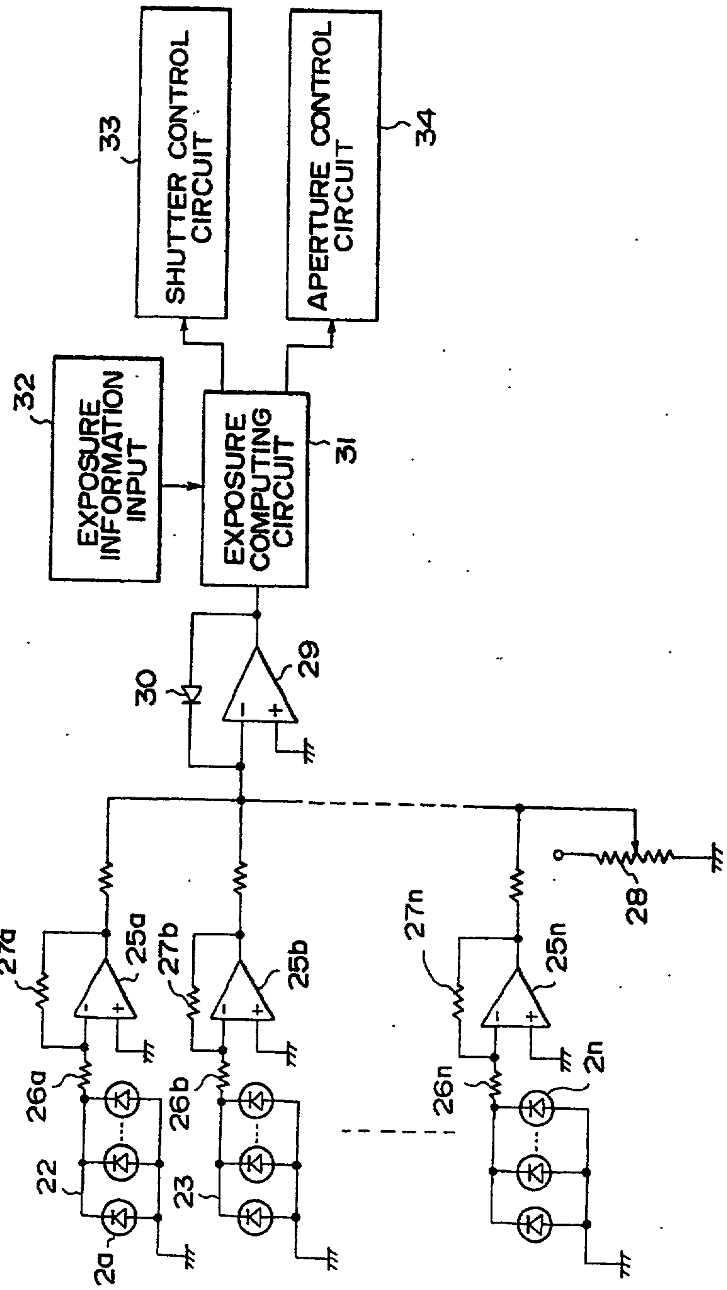

SHUTTER CONTROL CIRCUIT
33
APERTURE CONTROL CIRCUIT
34
EXPOSURE INFORMATION INPUT
32
EXPOSURE COMPUTING CIRCUIT
31
30
29
27a
25a
27b
25b
27n
25n
28
26a
26b
26n
2n
22
23
2a

FIG.8

FIG. 9

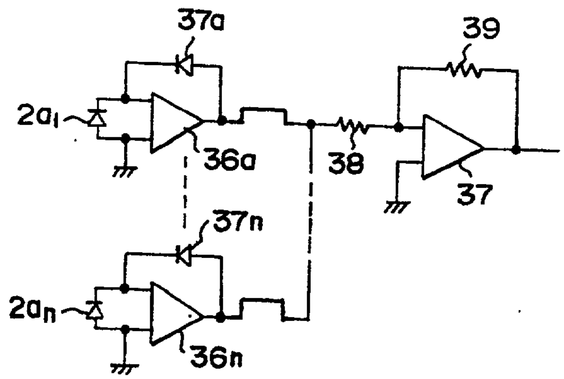

37a
39
$2a_1$
36a
38
37
37n
$2a_n$
36n

FIG. 10

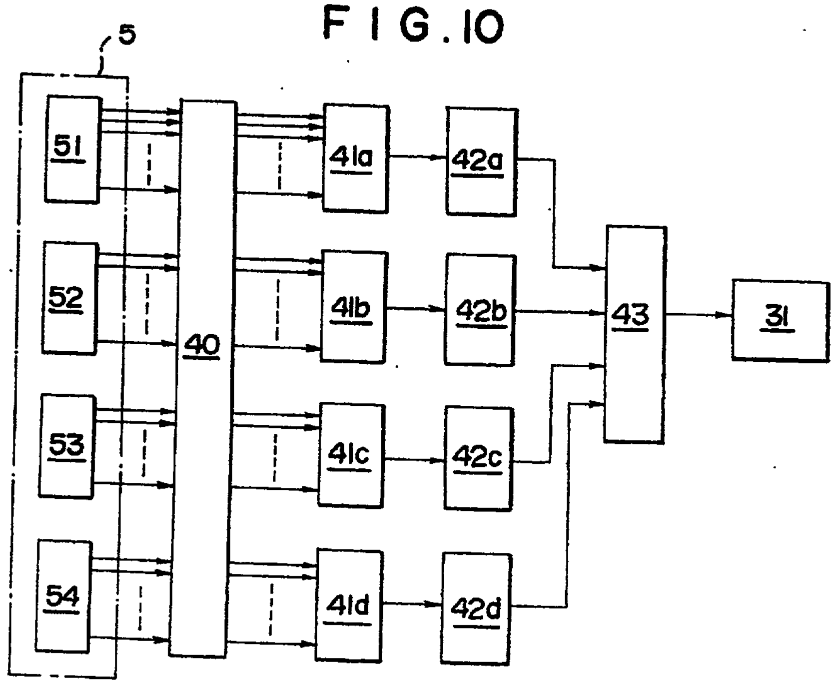

5
51
52
53
54
40
41a
41b
41c
41d
42a
42b
42c
42d
43
31

FIG. 11A

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

FIG. 11B

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

FIG. 11C

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

FIG. 13

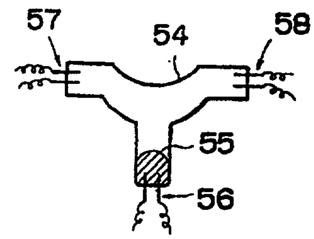


FIG. 14A

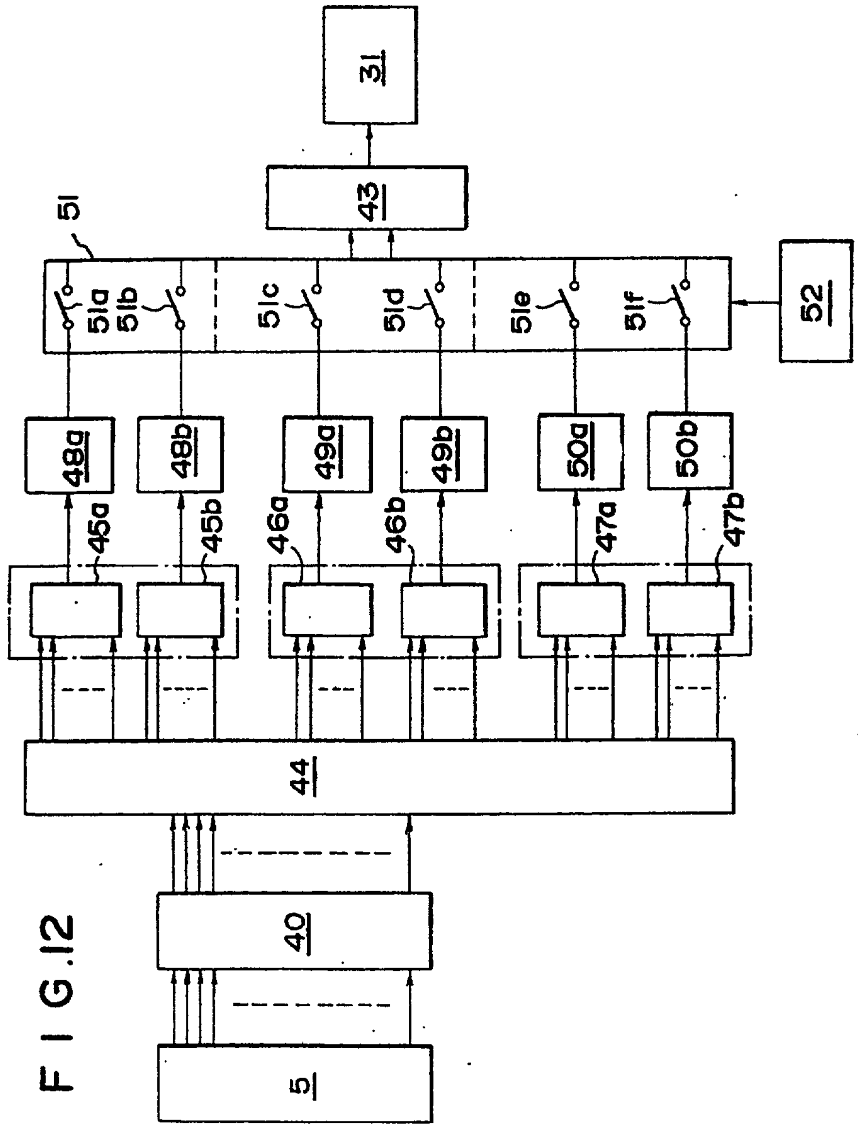
1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

FIG. 14B

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

FIG. 14C

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25


31
43
51
51a
51b
51c
51d
51e
51f
52
48a
48b
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49b
50a
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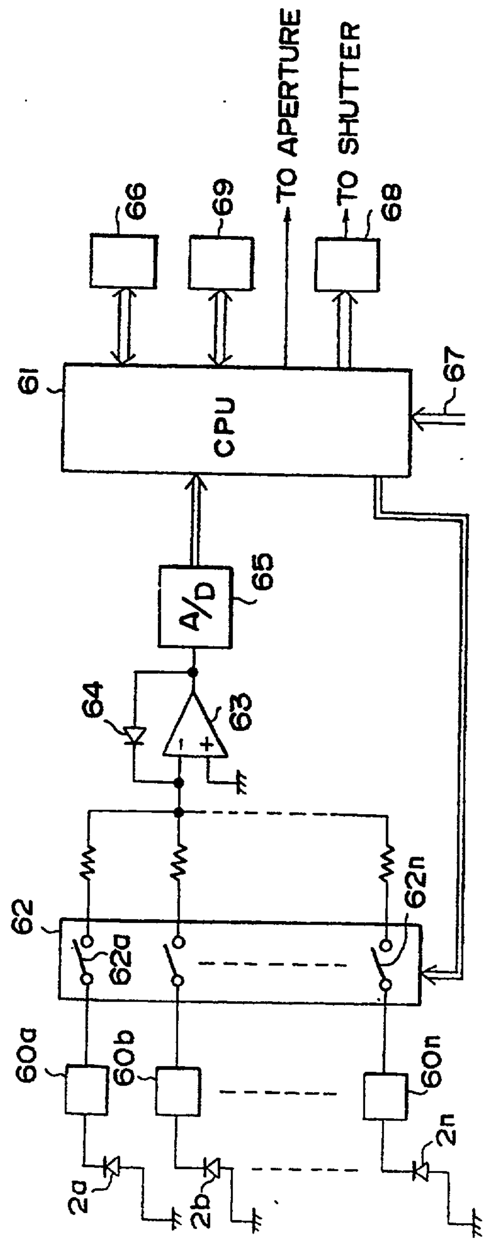
45a
45b
46a
46b
47a
47b
44
40
5

FIG.12



CPU
A/D
TO APERTURE
TO SHUTTER
61
62
62a
62n
63
64
65
66
67
68
69
60a
60b
60n
2a
2b
2n

F I G.15

FIG.16

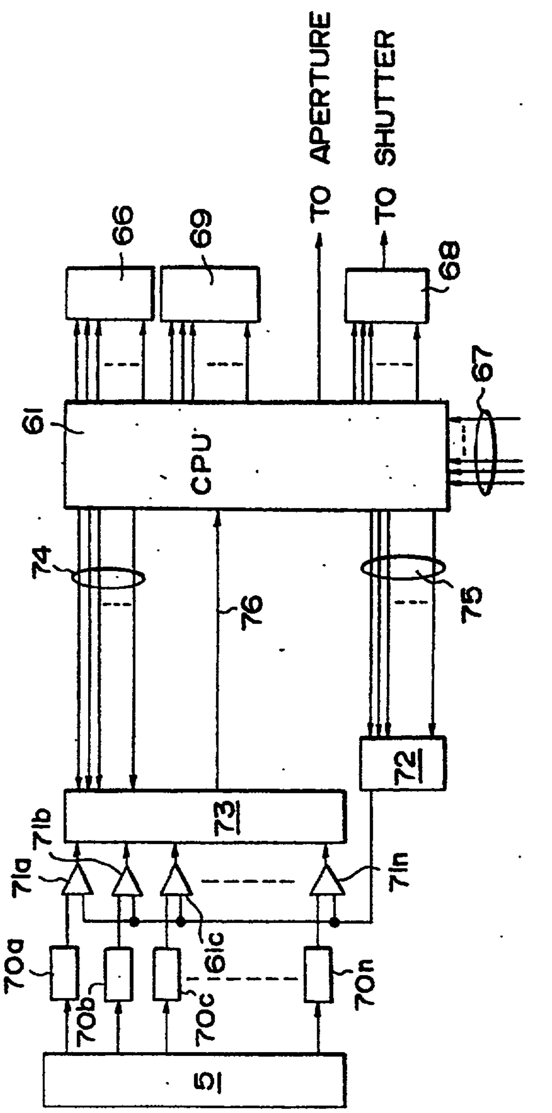
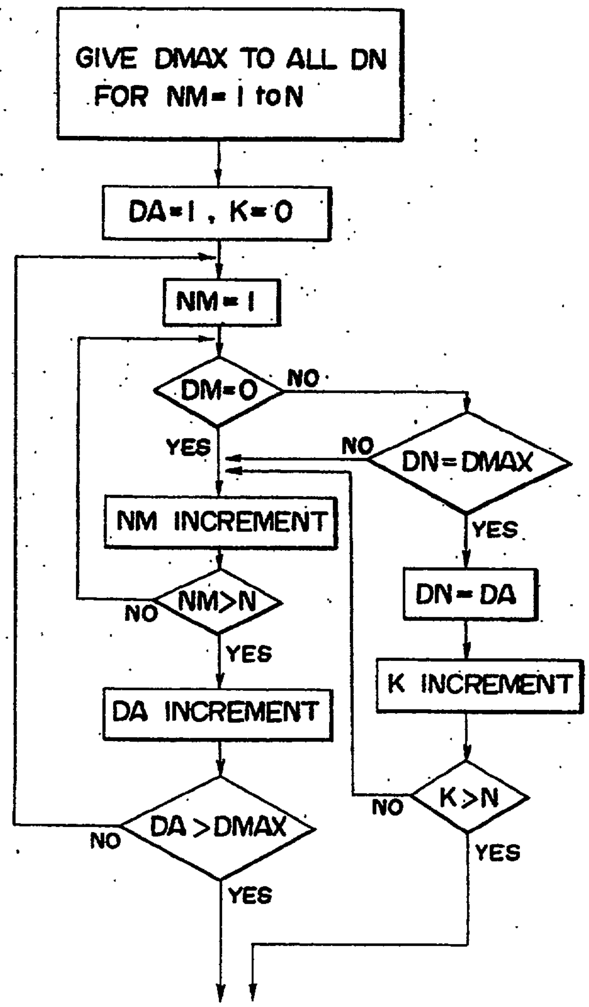

TO APERTURE
TO SHUTTER
66
69
68
67
61
CPU
74
76
75
72
73
71a
71b
71n
161c
70a
70b
70c
70n
51

FIG. 17


GIVE DMAX TO ALL DN FOR NM=1 to N
DA=1, K=0
NM=1
DM=0
NO
YES
DN=DMAX
NO
YES
NM INCREMENT
NM>N
NO
YES
DN=DA
K INCREMENT
DA INCREMENT
K>N
NO
YES
DA>DMAX
NO
YES

EXPOSURE CONTROL METHOD AND DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an exposure control method and a device therefor for use in a photographic camera, a motion picture camera, a television camera or the like, and more particularly to a method of controlling exposure for such an optical instrument in which the exposure is controlled based on the brightness of a focused image of the object to be photographed and an exposure control device for carrying out the method.

2. Description of the Prior Art

There have been known an average light measuring system in which one or two light measuring elements are used for measuring the brightness of the image of an object as a whole and a central spot light measuring system in which the central portion of the image is particularly measured. Further, recently it has been known to use a number of light measuring elements to measure the various portions of the image and detect the maximum and minimum brightness of the image to control exposure based on the maximum or minimum brightness or average brightness calculated therefrom.

The above-mentioned conventional methods of exposure control suffer from defects in that the obtained exposure becomes under or over depending upon the specific brightness distribution of the image as of back-light image or scene having a dark background.

SUMMARY OF THE INVENTION

The object of the present invention is, therefore, to provide a method of controlling exposure in which proper exposure can be obtained even when the image has uneven distribution of brightness.

Another object of the present invention is to provide a device for controlling exposure carrying out the above method of exposure control.

Still another object of the present invention is to provide a method of controlling exposure in which proper exposure can be obtained for various kinds of images by changing the light measuring mode depending upon the object.

A further object of the present invention is to provide a method for controlling exposure in which proper exposure can be obtained for various positions of the camera or the like by changing the light measuring mode depending upon the position of the camera.

A still further object of the present invention is to provide an exposure controlling device for carrying out the above methods in which proper exposure can be obtained for various kinds of objects and for various positions of the camera or the like.

The above objects of the invention are accomplished by dividing the light measuring range of an image of an object into a number of zones, arranging at least one light measuring elements in the respective zones, obtaining the average brightness of the image in the respective zones (Bmi), calculating the object brightness B based on the average brightnesses Bmi by the formula:

$$B = K_1 + \sum_{i=1}^{n} K_{(i+1)} \cdot Bmi \qquad (1)$$

(K_1, K_{i+1} are coefficients.), and controlling the exposure based on the object brightness B.

The average brightness Bmi is obtained by dividing the sum of the log-converted value of the measured brightness by the number of light measuring elements in the zone, or by obtaining the average of the brightness measured by the light measuring elements in the respective zones and log-converting the sum. Therefore, there is no fear that the brightness is effected by the high brightness portion of the object as experienced in the conventional central spot light measuring system.

The present invention is advantageous in that the most desirable complex zone pattern can easily be selected for the given object and further the average brightness of the respective zones can be properly weighted by use of proper weighting coefficients, and accordingly the exposure control can be conducted more properly than any conventional method.

The present invention is further advantageous in that the zone pattern can be changed for different scene of the object. For instance, in case of a spot light illuminated object, the image area is divided into concentric zones distributed around the center of the image, and in case of an object in back light the area is divided into zones distributed concentrically around a point a little below the center of the image area.

Further, it is possible to change the weighting coefficients for the respective zones for different scenes of the object. For instance, in case of a spot light illuminated object, the central zones are provided with larger weighting coefficients, and in case of a back light object the marginal zones are provided with smaller coefficients.

Furthermore, it is possible to obtain a whole average brightness (Bo) averaged throughout the whole image and use the same for correcting the exposure by adding the same to the above brightness (Bmi) after weighting the former.

In case that the zone pattern is asymmetrical and the position thereof changes as the position of the camera changes, the position of the camera is detected to correct the position of the zone pattern so that the zone pattern may properly be applied to the object image even when the camera position is changed.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a plan view of the light measuring portion used in the present invention,

FIGS. 2 to 5 are side sectional views showing the various arrangements of the light measuring portion used in the present invention,

FIG. 6 is a partial explanatory view showing an example of an arrangement of the light measuring elements connected with lead lines,

FIGS. 7A to 7H are front views showing various examples of the zone pattern,

FIG. 8 is a circuit view showing an embodiment of the exposure control device in accordance with the present invention,

FIG. 9 is a circuit view showing an example of a variation of the circuit in which the output of photodiodes is amplified before connected to the control circuit,

FIG. 10 is a block diagram showing another embodiment of the exposure control device in accordance with the present invention,

FIGS. 11A to 11C are front views showing the relationship between the position of the camera and the way of dividing the image area into zones,

FIG. 12 is a block diagram showing an exposure control device which is able to change the way of dividing the area into zones according to the position of the camera,

FIG. 13 is a front view showing an example of a camera position detecting means,

FIGS. 14A to 14C are front views showing another example of the way of dividing the area into zones,

FIG. 15 is a block diagram showing an embodiment of the exposure control device of this invention in which the way of dividing the area into zones can be changed by means of a switching circuit,

FIG. 16 is a block diagram showing an embodiment of a digital type exposure control device, and

FIG. 17 is a flow chart which shows the process of data input employed in the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now the present invention will be described in detail with reference to the accompanying drawings.

Referring to FIG. 1 showing the light measuring portion employed in the present invention, a number of light measuring elements 2a to 2n are provided on a base board 1 in the form of a matrix. The light measuring elements 2a to 2n may be in the form of photodiodes, photovoltaic elements, phototransistors, CdS, photo-charge storing type CCD (charge coupled device) and the like. Since the CCD has a narrow dynamic range, it is desirable that the storing time be changed according to the brightness of the object to control sensitivity.

FIGS. 2 to 5 show various examples of the light measuring portion. FIG. 2 shows an example in which the light measurement is conducted in parallel to the photographing system. In this example, an objective 3 is located in front of a light measuring portion 5 with the intervention of a stop 4 located therebetween. A taking lens 6 is provided separately therefrom in parallel thereto to focus an image on a photographic film 8 through a stop 7. Thus, the light measuring portion 5 measures the light from the object (not shown) to be photographed by the camera with the taking lens 6.

FIG. 3 shows another example in which a light measuring portion 5a is provided in a view finder. An objective 9 is provided in front of an eyepiece 11 with the intervention of a semi-transparent mirror 10 located therebetween. The semi-transparent mirror 10 reflectes a part of the light coming in through the objective 9 toward the light measuring portion 5a.

FIG. 4 shows another example in which a light measuring portion 5b is provided in a single lens reflex camera. A part of the swing-up mirror 14 is made transparent to transmit the light coming in from the taking lens 16. A concave mirror 15 is located behind the mirror 14 to reflect the light transmitting through the mirror 14 downward toward the light measuring portion 5b. A stop 17 is located behind the taking lens 16. Thus, a part of the light coming in through the taking lens 16 is focused on the light measuring portion 5b and forms a small image of the object to be photographed thereon.

FIG. 5 shows still another example in which light measuring portions 5c, 5d and 5e are located in the vicinity of a pentagonal prism 18 of a single lens reflex camera as shown in FIG. 4. The mirror 14 reflects the light coming in from the taking lens 16 upward. The light reflected upward by the mirror 14 enters a pentagonal prism 18 through a focusing glass 19 and a condenser lens 20. The light measuring portion 5c is located above the prism 18, 5d in front thereof and 5e therebehind. In front of the respective light measuring portions 5c, 5d and 5e are located focusing lenses 21c, 21d and 21e, respectively.

The light measuring portion 5 as mentioned hereinabove is provided with a number of light measuring elements 2a, 2b, . . . 2f connected by means of lead wires 22 and 23 according to the group of the elements divided in zones. In the example shown in FIG. 6, elements 2a, 2b and 2d are connected together and elements 2c, 2e and 2f are connected together. The former three make one zone and are grouped together and the latter three make another zone and are grouped together. By dividing the light measuring elements 2a, 2b, . . . light photodiodes into two groups, it is possible to divide the image area into two zones as illustrated in FIGS. 7A to 7C. Further, by dividing the area into more zones, the area can be divided as shown in FIGS. 7D to 7H, for example. In the example as shown in FIG. 7H, the image area or the light measuring portion is divided into three zones, i.e. one being illustrated as blank zone, another as hatched zone and the other as cross-hatched zone each zone consisting of a plurality of elements.

Since the brightness of the marginal portion of the image is low due to the optical performance of the objective or the taking lens, the output of the light measuring elements located in the marginal region of the focused image is low. Therefore, it is desirable that the light receiving area of the light measuring elements located in the marginal portion or the area of the zone in the marginal portion be made larger than that of the central portion.

The zone pattern as shown in FIG. 7B or 7D is symmetric both vertical and horizontally. Therefore, the pattern does not change with the position of the camera. The zone pattern as shown in FIG. 7D is used with the weighting coefficients as follows for example, where the coefficients Ki correspond to those shown in formula (1):

$K_1=1.43$, $K_2=0.53$ (coefficient of zone Z_1),
$K_3=0.12$ (of zone Z_2), $K_4=-0.08$ (of zone Z_3),
$K_5=0.34$ (of zone Z_4).

The exposure control method and device in accordance with the present invention employs the light measuring portion 5, 5a, 5b . . . as shown above in FIGS. 7A to 7H located at the position as shown in FIGS. 2 to 5, for example. Now the exposure control circuit connected with the light measuring portion employed in the present invention will be described in detail with reference to FIG. 8.

FIG. 8 shows an example of the exposure control circuit employed in the present invention. The photodiodes 2a, 2b, . . . 2n as shown in FIG. 6 grouped for the zones are connected respectively to operational amplifiers 25a, 25b, . . . 25n. The operational amplifiers 25a, . . . 25n are provided with resistors 26a . . . 26n and feedback resistors 27a . . . 27n for controlling the gain thereof. The gain is controlled to provide a weighting coefficient for the averaged value of the outputs of the light measuring elements in the zone.

The weighted output signals of the zones weighted by the operational amplifiers 25a . . . 25n and the output signal from a potentiometer 28 for providing the con-

stant value K_i of the formula (1) are inputed into an operational amplifier 29 and log-converted by a log-diode 30 and summed up. In this embodiment the averaged values are all summed up. However, it is possible to subtract one output signal of a light measuring zone from the sum of the output signals of the other light measuring zones. For example, when the image includes a bright sky, it is possible to subtract the output of the zone corresponding to the sky from the sum of the outputs of the other zones.

The output of the operational amplifier 29 is sent to an exposure computing circuit 31 as the object brightness information, where a photographic calculation is conducted together with a film sensitivity and the like from an exposure information input means 32. The output of the exposure computing circuit 31 controls the shutter control circuit 33 or the aperture control circuit 34 connected thereto. In the above embodiment as shown in FIG. 8, the photodiodes 2a in the same group are connected in parallel directly with lead wires. However, the photodiodes may be connected after amplified by amplifiers.

FIG. 9 shows one of such examples in which the photodiodes $2a_1 \ldots 2a_n$ are respectively connected with operational amplifiers 36a . . . 36n and the output of the photodiodes are amplified thereby. At the same time, the photodiodes $2a_1 \ldots 2a_n$ are connected with log-diodes 37a . . . 37n which are connected in parallel with the operational amplifiers 36a . . . 36n. Thus, the output of the photodiodes $2a_1 \ldots 2a_n$ is subjected to log-conversion and impedance conversion. The output signals of the operational amplifiers 36a . . . 36n are inputed into an operational amplifier 37 and summed up here. The resistors 38 and 39 connected before and in parallel to the operational amplifier 37 are used for weighting the averaged value of the output signals.

FIG. 10 shows another example of the exposure control device in accordance with the present invention in which the light measuring portion as shown in FIG. 7D is employed. The light measuring portion 5 is divided into four zones 5_1, 5_2, 5_3 and 5_4 which are connected with a log-conversion circuit 40.

The log-conversion circuit 40 is constituted of a set of operational amplifiers and log diodes connected in the feed-back circuit thereof for the respective light measuring elements $2a_1 \ldots 2a_n$ in the respective light measuring zones.

The log-converted signals are inputed into adding circuits 41a . . . 41d provided for the respective zones $5_1 \ldots 5_4$ and summed up. As the adding circuits 41a . . . 41d, adders using operational amplifiers can be used.

The output signals of the adding circuits 41a . . . 41d are inputed into dividing circuits 42a . . . 42d and divided by a coefficient determined for the area of the zones. By this division, the average brightness Bmi for the respective zones is calculated.

The average brightness thus obtained is inputed into a weighting adding-and-subtracting circuit 43 and addition and subtraction are conducted after being weighted. Thus, the operation of the formula (1) is conducted by the circuit 43 to calculate the object brightness B. The brightness B thus obtained is inputed into the exposure calculating circuit 31.

FIGS. 11A to 11C show embodiments in which the light measuring portion is divided into two zones. Since the zones are divided into asymmetric pattern with respect to the horizontal central line, the position of the zones change as the position of the camera changes. FIG. 11A shows the zone pattern in which the camera is held horizontally, namely in its normal position. FIG. 11B shows the zone pattern in which the camera is held with its left side up. FIG. 11C shows the zone pattern in which the camera is held with its right side up. The light measuring elements are numbered 1 to 25. In the position of FIG. 11A, elements 12, 13, 14, 17, 18, 19, 22, 23 and 24 are grouped into one zone and the others are grouped into the other zone. In FIG. 11B, 8,9,10,13,14,15,18,19 and 20 are grouped into one zone and the remainder into the other, and in FIG. 11C, 6,7,8,11,12,13,16,17 and 18 are grouped into one zone and the remainder into the other.

FIG. 12 shows an embodiment of the exposure control device in accordance with the present invention in which the light measuring portion as shown in FIGS. 11A to 11C having two zones asymmetrically divided is used. The output of the light measuring portion 5 is first log-converted by a log-conversion circuit 40 and then inputed into a matrix circuit 44. The matrix circuit 44 makes three groups each consisting of two groups for the three different positions.

In more detail, in case of FIG. 11A in which the camera is held horizontally, the lower central nine elements grouped into one zone and the remainder are connected to two adding circuits 45a and 45b, respectively. In case of FIG. 11B in which the camera is held with left side up, the right central nine elements grouped into one zone and the remainder are connected to adding circuits 46a and 46b, respectively. Similarly, in case of FIG. 11C, the left central nine elements and the remainder are connected with adding circuits 47a and 47b, respectively.

The outputs of these adding circuits 45a,45b,46a,46b,-47a and 47b are inputed into dividing circuits 48a,48b,-49a,49b,50a and 50b, respectively. The dividing circuits divide the summed value by the number of the light measuring elements in each zone.

The average brightness is thus obtained for three kinds of zone pattern for three different positions of the camera. One of the three average brightness outputs is selected according to the position of the camera by means of an analog switch 51. The analog switch 51 is connected with a camera position detecting means 52 and one of three sets of switches 51a,51b, 51c,51d, and 51e,51f is turned on according to the detected position of the camera. When the camera is in the horizontal position, analog switches 51a and 51b are turned on to transmit the output of the dividing circuit 48a and 48b to a brightness calculating circuit 43. When the camera is held with the left side up, the analog switches 51c and 51d are turned on and when right side up the switches 51e and 51f are turned on. The circuit 43 is connected with an exposure computing circuit 31. FIG. 13 shows an example of the camera position detecting means. A Y-shaped glass tube 54 is filled with mercury 55. The mercury 55 moves within the glass tube 54 as the position of the camera changes. When the camera is held horizontally, the mercury 55 stays in the lower section of the Y-shaped glass tube 54 as shown in FIG. 13 and electrically closes the switch 56 which corresponds to the first set of analog switches 51a and 51b mentioned above for instance. When the camera is moved to the left side up position in FIG. 13, the mercury 55 moves to the position to close the switch 58.

The coefficients Ki for the formula (1) for the other examples of the zone pattern may be determined as follows for example.

For the example as shown in FIG. 7C in which the light receiving area is divided into a rectangular section at the lower center and a U-shaped outer section, the coefficients for the formula (1) may be determined as follows:

$K_1=1.80$, $K_2=0.69$ (central), $K_3=0.21$ (outer).

For the example as shown in FIGS. 14A to 14C in which the light receiving area of the light measuring portion is divided into a lower central small section, a middle O-shaped section and an outer U-shaped section, the coefficients may be determined as follows:

$K_1=1.64$, $K_2=0.22$ (central), $K_3=0.42$ (middle), $K_4=0.27$ (outer).

FIG. 15 shows another embodiment in which the zone pattern can be freely changed by selecting connection of the photodiodes by use of a switch circuit. Photodiodes **2a** . . . **2n** are connected with buffer circuits **60a** . . . **60n** respectively, which in turn are connected with a switch circuit **62** in which selected switches **62a** . . . **62n** included in the same zone designated by a code signal from a CPU **61** are turned on. By the switch circuit **62** the output signal of the photodiodes in the same zone are inputed into an operational amplifier **63** and summed up being log-converted by a log-diode **64**.

The output signal of the operational amplifier **63** is recorded in a RAM **66** after converted to a digital signal by an A/D converter **65**.

Then, turning on another set of switches **62a** . . . **62n** selected by the designation by the CPU **61** to sum up the outputs of another group of photodiodes included in another zone, the output representing the brightness of the image covering this zone is obtained. This output is similarly A/D converted and recorded in the RAM **66**. Thus, the data for all the zones are recorded in the RAM **66**. After all the data are recorded in the RAM **66**, the brightness information B is finally obtained by use of the formula (1).

From the camera side, exposure information representing the film sensitivity, aperture size or shutter speed and the position of the camera is given in the form of an exposure information signal **67** and inputed into the CPU **61** constituted of a microcomputer or the like.

A shutter control circuit **68** is connected with the CPU **61** and functions as both a timer and a buffer and outputs a shutter control signal based on a code signal from the CPU **61**.

Further, a ROM **69** is connected with the CPU **61** in which are recorded the program for designating the zone and the program for calculating the finally desired exposure factor based on the exposure information given by the exposure information signal **67**.

Further, in the embodiment as shown in FIG. **15**, it is possible to change the combination of the photodiodes **2a** . . . **2n** depending upon various conditions. For instance, when the brightness of the object is too low to conduct a proper light measurement due to insufficient sensitivity of the light measuring portion **5**, the switch circuit **62** is controlled by the order of the ROM **69** to increase the number of photodiodes which constitute one zone. For example, when 64 photodiodes are used to make 64 picture cells, four photodiodes located adjacent to each other can be made to form one picture cell and accordingly 16 picture cells in all. The 16 picture cells are properly divided to make several zones. In case of such an object of low brightness, the reduction of the number of picture cells does not affect the light measurement since the contrast is not so high.

Further, in the above described digital circuit, the load of the CPU **61** is not so large since the data are inputed into the CPU **61** after the data are subjected to an analog calculation. Therefore, the capacity of the RAM **66** and the processing time can be saved.

FIG. **16** shows another embodiment of the exposure control circuit. This embodiment is of digital type. The outputs of the light measuring portion **5** are inputed into log-conversion circuits **70a** . . . **70n** respectively. The outputs of the log-conversion circuits **70a** . . . **70n** are inputed into comparators **71a** . . . **71n**, respectively, which in turn compare the received outputs from the log-conversion circuits **70a** . . . **70n** with a reference signal from a D/A conversion circuit **72**. The outputs of the comparators **71a** . . . **71n** are connected with a multiplexer **73**. The multiplexer **73** selects one comparator among the number of comparators **71a** . . . **71n** based on the multiplexer address signal **74** from the microcomputer CPU **61**. After one of the comparator, e.g. **71a**, is selected by the multiplexer **73**, a set value signal **75** indicating the set value to which the output from the log-conversion circuit **70a** is counted up is sent to the D/A converter **72** and the comparator **71a** starts to compare the output with the reference signal from the D/A conversion circuit **72**. The reference signal from circuit **72** gradually increases and is compared with the output of the log-conversion circuit **70a** by the comparator **71a**. When the level of the reference signal reaches the level of the output from circuit **70a**, an agreement signal is outputed by the comparator **71a**. Then, the multiplexer **73** outputs the agreement signal **76** which in turn is inputed into the CPU **61**.

Since the address of the light measuring element in the light measuring portion **5** is known from the multiplexer address signal **74** and the digital value is known from the set value signal **75**, when the agreement signal **76** is outputed the set value is recorded in the address in the RAM **66** corresponding said address of the light measuring elements.

Then, after the multiplexer address signal **74** is incremented the output signal of the log-conversion circuit **70b** next to said circuit **70a** is similarly recorded in the RAM **66**.

FIG. **17** shows the above process of recording the data in the RAM **66** after A/D conversion thereof, in which the reference characters mean the factors as follows:

DM: log-converted output of light measuring elements
DA: set value of D/A converter
NM: address of light measuring elements
N: number of light measuring elements
DMAX: maximum value set by D/A converter
DN: content of DA.

We claim:

1. A method of controlling exposure based on the brightness of an object measured by light measuring means comprising steps of

arranging a number of light measuring elements in a light measuring area for measuring the brightness of the object the image of which is focused on said light measuring area, said light measuring elements outputing a signal representing the brightness measured thereby,

dividing said light measuring area into n-number of zones of a desired pattern, each zone including at least one of said light measuring elements,

obtaining an average brightness Bmi (i: address of the zone) of said zone by calculation based on the output signals of said light measuring elements,

obtaining the object brightness B by calculation based on said average brightness Bmi by use of a formula of

$$B = \sum_{i=1}^{n} K_{i+1} \cdot Bmi$$

where K^1 and K_{i+1} are coefficients,

controlling exposure based on the object of brightness B; and

dividing said light measuring area into different patterns of zones for different positions of the optical instrument to which the method is applied.

2. A method of controlling exposure based on the brightness of an object measured by light measuring means comprising steps of

arranging a number of light measuring elements in a light measuring area for measuring the brightness of the object the image of which is focused on said light measuring area, said light measuring elements outputing a signal representing the brightness measured thereby,

dividing said light measuring area into n-number of zones of a desired pattern, each zone including at least one of said light measuring elements,

obtaining an average brightness Bmi (i: address of the zone) of said zone by calculation based on the output signals of said light measuring elements,

obtaining the object brightness B by calculation based on said average brightness Bmi by use of a formula of

$$B = \sum_{i=1}^{n} K_{i+1} \cdot Bmi$$

where K^1 and K_{i+1} are coefficients,

controlling exposure based on the object of brightness B;

dividing said light measuring area into different patterns of zones for different positions of the optical instrument to which the method is applied; and

dividing said light measuring area into different patterns of zones for different kinds of objects.

3. An exposure control device for controlling exposure based on the brightness of an object measured by light measuring means which measures the brightness of the object the image of which is focused on a light measuring area wherein the improvement comprises;

a number of light measuring elements arranged in said light measuring area,

means for obtaining an average output of the outputs of said light measuring elements in each zone,

means for weighting the averaged outputs and summing up the weighted outputs,

means for controlling exposure based on the brightness of the object obtained by summing up the weighted outputs; and

said light measuring elements being connected to one input terminal of an operational amplifier by way of analog gates, said analog gates being selectively turned on to input desired outputs of the light measuring elements into said operational amplifier.

* * * * *

United States Patent [19]
Bayer

[11] **3,971,065**
[45] **July 20, 1976**

[54] **COLOR IMAGING ARRAY**

[75] Inventor: **Bryce E. Bayer**, Rochester, N.Y.

[73] Assignee: **Eastman Kodak Company**, Rochester, N.Y.

[22] Filed: **Mar. 5, 1975**

[21] Appl. No.: **555,477**

[52] **U.S. Cl.** .... **358/41**; 350/162 SF; 350/317; 358/44
[51] **Int. Cl.**^{2} **H04N 9/24**
[58] **Field of Search** .... 358/44, 45, 46, 47, 358/48; 350/317, 162 SF; 315/169 TV

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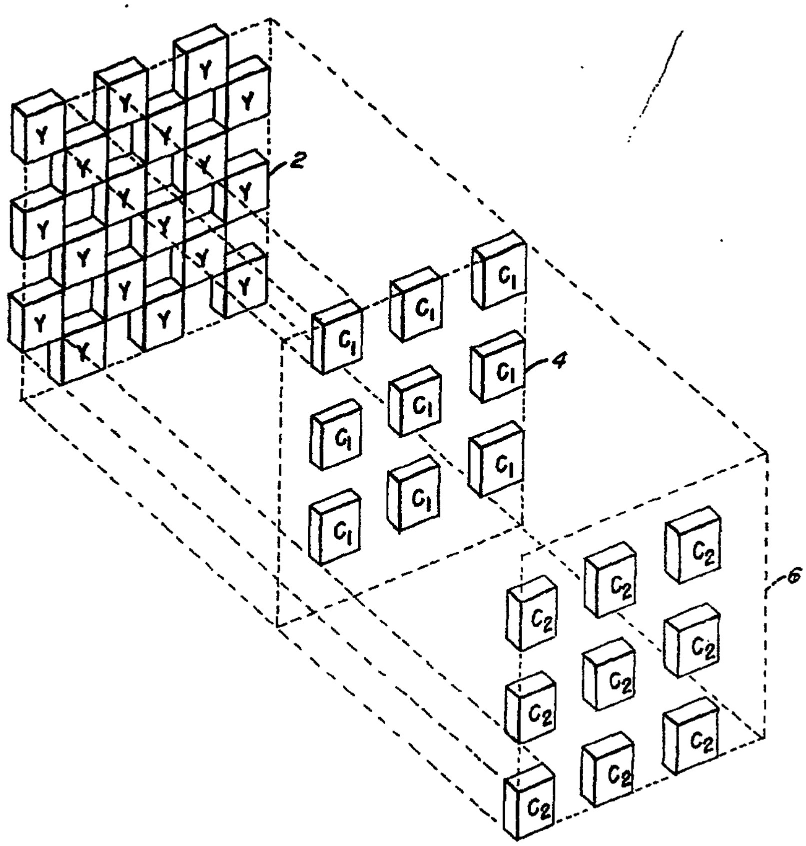
Primary Examiner—George H. Libman
Attorney, Agent, or Firm—George E. Grosser

[57] **ABSTRACT**

A sensing array for color imaging includes individual luminance- and chrominance-sensitive elements that are so intermixed that each type of element (i.e., according to sensitivity characteristics) occurs in a repeated pattern with luminance elements dominating the array. Preferably, luminance elements occur at every other element position to provide a relatively high frequency sampling pattern which is uniform in two perpendicular directions (e.g., horizontal and vertical). The chrominance patterns are interlaid therewith and fill the remaining element positions to provide relatively lower frequencies of sampling.

In a presently preferred implementation, a mosaic of selectively transmissive filters is superposed in registration with a solid state imaging array having a broad range of light sensitivity, the distribution of filter types in the mosaic being in accordance with the above-described patterns.

11 Claims, 10 Drawing Figures



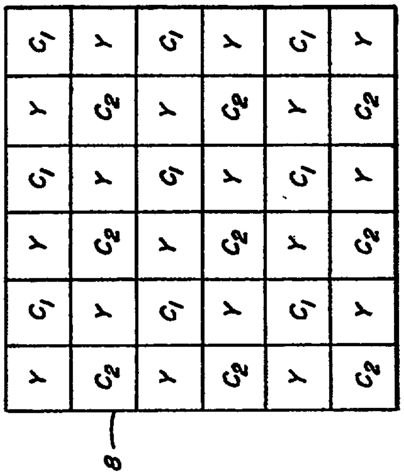


FIG. 1B

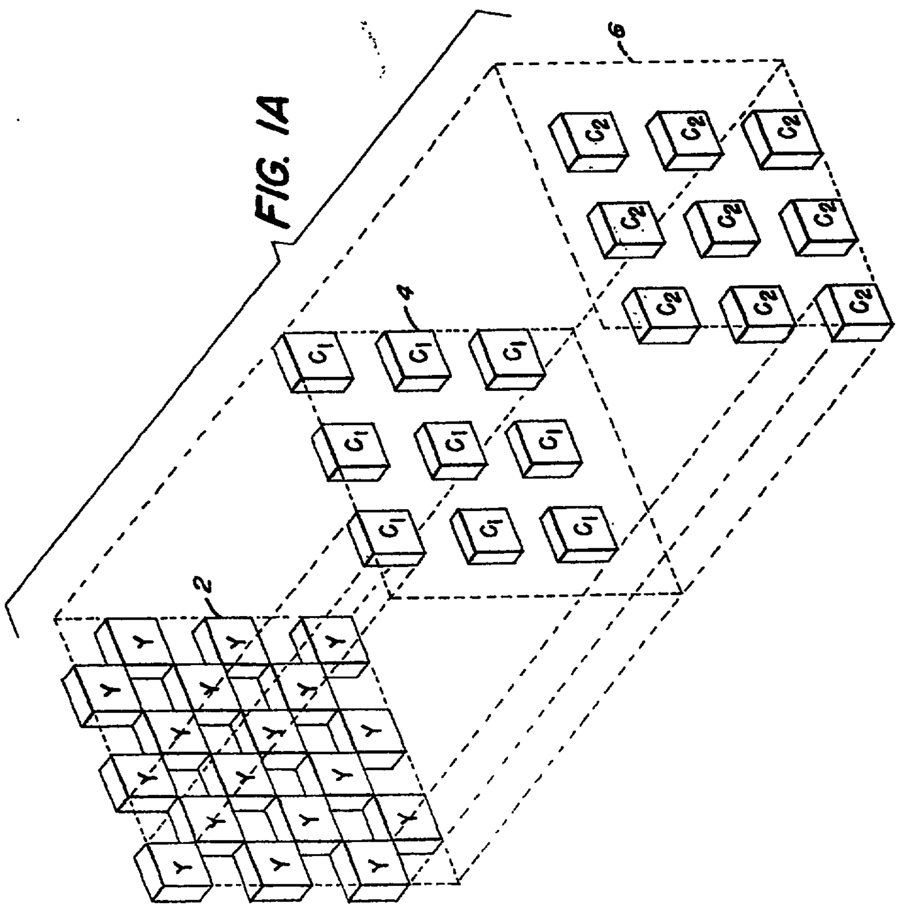


FIG. 1A

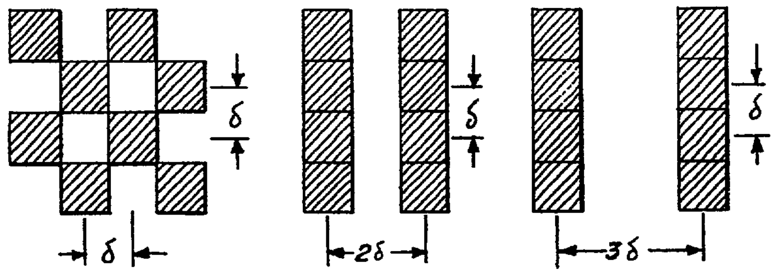


FIG. 2A FIG. 2B FIG. 2C

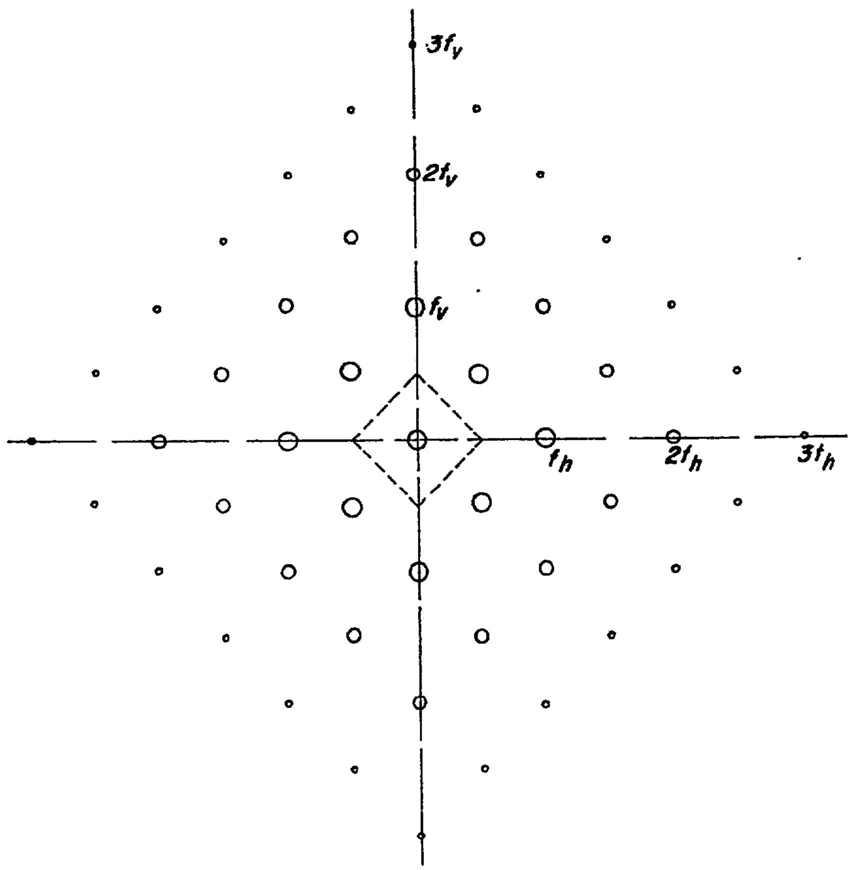


FIG. 2D

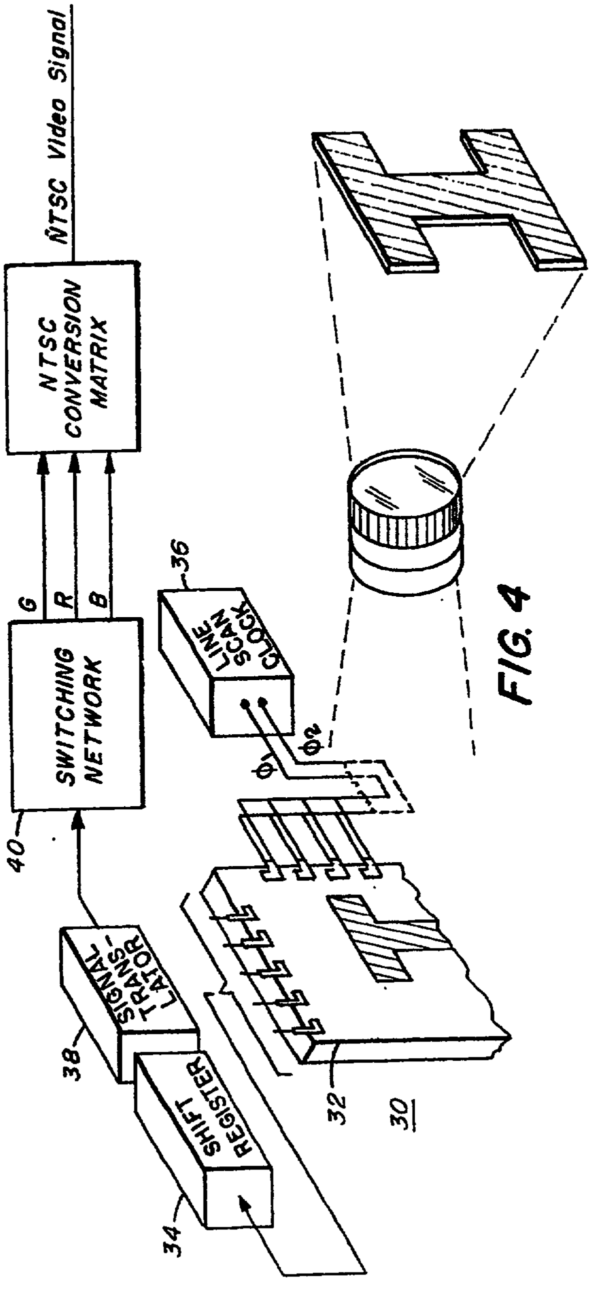


FIG. 4

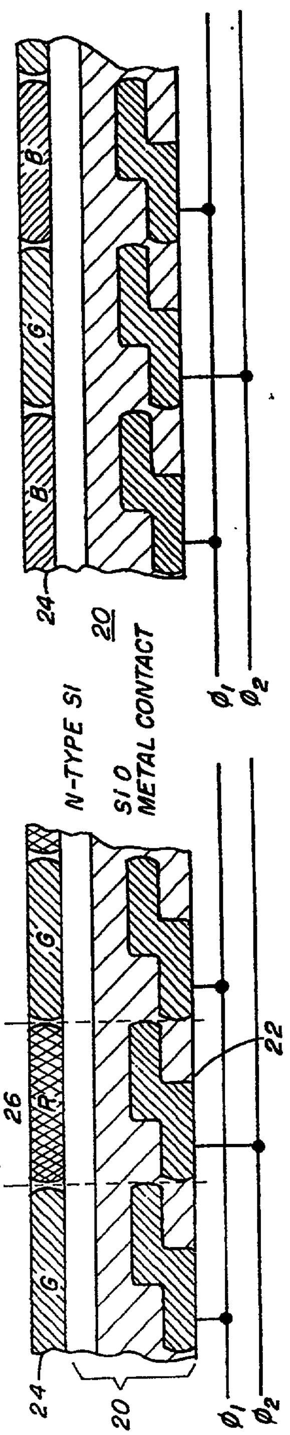


FIG. 3B

FIG. 3A

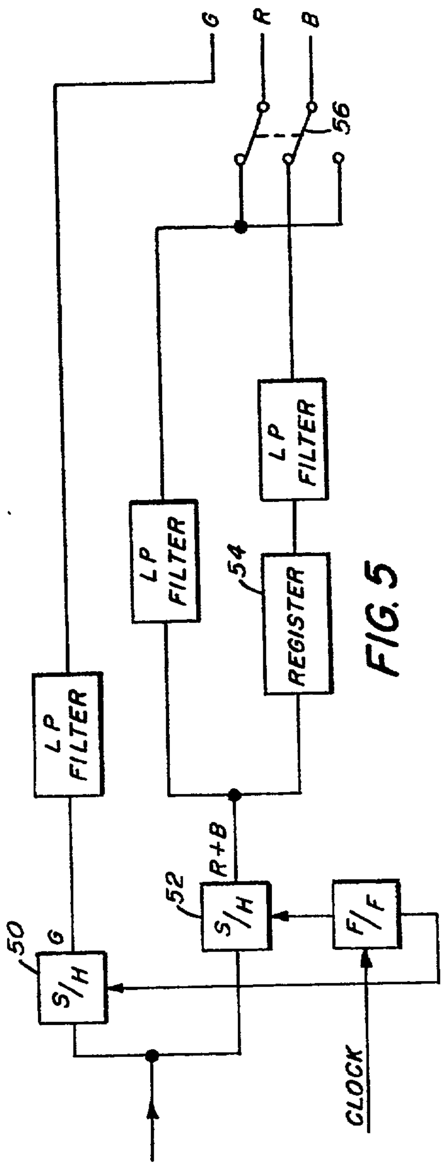

G
R
B
56
LP FILTER
LP FILTER
54
REGISTER
LP FILTER
50
G
S/H
52
R+B
S/H
F/F
CLOCK

FIG. 5

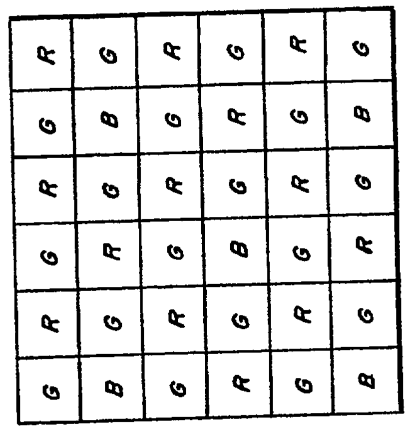

R G R G R G
G B G R G B
R G R G R G
G R G B G R
R G R G R G
G B G R G B

FIG. 6

COLOR IMAGING ARRAY

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to imaging devices and, in particular, to color image sensors.

2. Description Relative to the Prior Art

Color image sensors of various types have been proposed for and used in video cameras. To avoid optical complexity and problems with image registration, it is highly desirable that color image sensing occur at a single imaging site, e.g., at a single planar photosensitive array. Difficulty is encountered with such "single-site" color imaging, however, because at least three distinct types of color information must be extracted in order to represent a color image in video signal form.

One known approach to providing a single-site color sensing device utilizes a single image sensor of broad wavelength sensitivity and a cooperating filter disc which passes a series of color filters through the image beam in a repeating sequence. The filter interpositions are synchronized to image scanning, a filter typically being interposed during an entire field scan. Devices operating in this manner are said to produce a "field sequential" color signal. One problem with this approach is that the resulting signal presents the extracted color image information in a time order which is radically different from the time order of the standard NTSC video signal. A further disadvantage is that some of the color image information (e.g., blue image information if a blue basic color vector is utilized) tends to be disproportionately detailed and hence wasteful of sensor capacity in consideration of the response characteristics of the human visual system.

Certain other proposed approaches to achieving single-site color image sensing call for the use of striped color filters superposed on a single image sensor. One such type of image sensor utilizes filter grids which are angularly superimposed on one another (see U.S. Pat. No. 3,378,633). As a result of image scanning, such image sensors produce a composite signal wherein chrominance information is represented in the form of modulated carrier signals. Such apparatus may be adapted to produce signals in the NTSC format or, if desired, the color image information can be separated by frequency domain techniques. In practice, however, it has proven difficult to produce such sensors economically, particularly where detailed image information is required.

Striped filters which transmit a repeating sequence of three or more spectral bands have also been proposed for use in color imaging. With this arrangement, the filters are typically aligned vertically and scanning of the image is performed horizontally. In effect, elemental sample areas are defined along the filter stripes. With this arrangement, it will be appreciated, sampling for a given color is not uniform for horizontal and vertical directions. Additionally, the sampling patterns which result tend to provide a disproportionate quantity of information regarding basic color vectors to which the eye has less resolving power, e.g., "blue" information relative to "green" information.

Another approach to color imaging which has been proposed is the "dot" scanning system, as discussed in U.S. Pat. No. 2,683,769 to Banning. That approach generally utilizes spectrally selective sensor elements which are arranged in triads (red, green, and blue elements, respectively). However, in U.S. Pat. No. 2,755,334, also to Banning, a repeated arrangement of four element groupings (red-, green-, blue-, and white-sensitive elements, respectively) is described. Such approaches to color imaging have not been of practical significance, in part because of the cost of fabricating the number of individual elements which are required to provide image information having adequate detail.

In summary, while color imaging devices having a single imaging site are desirable to minimize optical and registration problems and to provide a more rugged camera structure, video camera manufacturers generally resort to splitting the image beam and providing multiple image scanners in order to achieve a satisfactory type and quality of color video signal.

SUMMARY OF THE INVENTION

Color imaging is effected by a single imaging array composed of individual luminance and chrominance sensing elements that are distributed according to type (sensitivity) in repeating interlaid patterns, the luminance pattern exhibiting the highest frequency of occurrence — and therefore the highest frequency of image sampling — irrespective of direction on the array.

In providing for a dominance of luminance sampling, recognition is taken of the human visual system's relatively greater ability to discern luminance detail. By arranging the luminance elements of the color image sensing array to occur at every other array position, a dominance of luminance elements is achieved in a pattern which has the special advantage of uniformity in two orthogonal directions (e.g., horizontal and vertical). Moreover, by so intermixing three types of elements (luminance, and first and second chrominance) that luminance elements occur at every other array position, and first and second chrominance elements alternate with such luminance elements in respective alternate rows of the array, there is provided a luminance-dominated sampling which is uniform for all three color vectors in two orthogonal directions. Certain desirable sampling attributes which result from the special uniformities of such arrangements are discussed in the detailed description below.

Preferably, to produce an element array according to the invention, a solid state sensor array of broad wavelength sensitivity is provided with a superposed filter mosaic. Filters of the mosaic are arranged in one-to-one registration with elements of the sensor array and have light passing characteristics in accordance with the above-described interlaid pattens. Filters which are selectively transparent in the green region of the spectrum are preferably employed in producing luminance-type elements, and filters which are selectively transparent in the red and blue spectral regions, respectively, are preferably employed in producing chrominance-type elements. (The term "luminance" is herein used in a broad sense to refer to the color vector which is the major contributor of luminance information. The term "chrominance" refers to those color vectors other than the luminance color vectors which provide a basis for defining an image.)

In an important alternative for implementation of the invention, three interlaid patterns, (a green-, a red-, and a blue-sensitive element pattern) are so arranged that green-sensitive elements (serving to detect luminance) occur at every other array position, with red-sensitive elements alternating with such green-sensitive

elements in alternate rows — as in the case for the presently preferred implementation. In the remaining element positions, however, blue-sensitive elements alternate with red-sensitive elements to produce a luminance-dominated image sampling having a disproportion in the chrominance samples favoring red over blue. With this arrangement, sampling rates for all three basic color vectors are adjusted respective of the acuity of the human visual system. That is, blue detail, to which the human visual has least resolution, is sampled the least frequently . . . green detail, to which the human visual system is most responsive, is sampled most frequently.

It will be appreciated from the foregoing that with selectively sensitized elements cooperating in interlaid sampling patterns according to the invention, image information is extracted with an efficient use of sensing elements because relative image sampling rates, by color, are in effect adjusted respective of the characteristics of human visual response. Moreover, with the uniformities of such interlaid sampling patterns, desirable sampling attributes are achieved for a plurality of sensing element types (color sensitivities) cooperating in a color imaging device.

The invention is described with reference to the drawings, wherein:

FIG. 1A is an exploded pictorial representation showing preferred sensing element patterns for practicing the invention;

FIG. 1B is a pictorial representaion corresponding to FIG. 1A;

FIGS. 2A, 2B, 2C, and 2D are patten representations teaching a sampling characteristic of preferred forms of the invention;

FIG. 3A is a cross-sectional representation, in part, of a row of sensing elements in accordance with a preferred implementation of the invention;

FIG. 3B is a cross-sectional representation, in part, of a row of sensing elements adjacent the row represented in FIG. 3A;

FIG. 4 is a perspective representation showing a basic arrangement of elements for a camera system according to the invention;

FIG. 5 is a diagrammatic representation generally in block form illustrating signal processing arrangements for use in conjunction with sensing arrays according to the invention; and

FIG. 6 is a planar view of another embodiment of the invention.

Referring now to FIGS. 1A and 1B, there is shown a set of three sensor patterns 2, 4, and 6, respectively, which are interlaid to form an image sampling array 8, each such pattern corresponding to a different basic color vector. The pattern 2 (hereinafter referred to as the luminance pattern) has the highest element population, and is made up of luminance-sensitive elements (denoted Y), which are arranged at every other element position. With this pattern, it will be appreciated, luminance elements (and hence luminance samples) occur at half of the element positions of the array and are uniformly distributed over the entire array. First and second chrominance patterns 4 and 6 alternate with the luminance pattern in alternate rows, respectively, to provide a composite sampling array devoid of overlapping. As a result of this arrangement, sampling of an image, for all three basic color vectors (i.e., luminance, first and second chrominance), is symmetrical and uniform in two orthogonal directions (e.g., horizontal and vertical), as is readily seen from FIG. 1B.

FIGS. 2A, 2B, and 2C illustrate the advance over certain prior art by means of the invention. Referring to FIGS. 2A, 2B, and 2C, the distance between rows of elements in the horizontal and vertical directions is shown for the luminance pattern 2 (FIG. 1A), and for prior art striped element patterns (e.g., as would exist where a vertically striped filter is superposed on a sensor array). Luminance pattern 2 (FIG. 2A) is seen to provide uniform sampling in the horizontal and vertical directions, whereas the striped patterns of FIGS. 2B and 2C do not. (Note: FIG. 2B shows a striped arrangement having a numerically similar luminance element population, and FIG. 2C shows a striped filter of the type having alternating stripes for each of three basic color vectors.) For each row and column of elements, the FIG. 2A luminance elements (and hence luminance samples) occur at regular intervals. Moreover, by means of the invention, not only the luminance pattern, but all other patterns (4 and 6, FIG. 1A) of a sensor according to the invention become regular and uniform in two orthogonal directions.

The preferred luminance pattern as especially desirable sampling qualities which result from the uniformity and orientation thereof. Of the possible patterns including only half of the element positions of a substantially rectangular array, the preferred pattern is the one that affords the largest useful region of frequency space, i.e., considering all directions on the array, the minimum Nyquist limit is largest. Moreover, because of the orientation of the preferred pattern to the major axes, this usable region proves more extensive in the horizontal and vertical directions . . . those directions where the human visual system is said to have greatest resolving power.

To further explain these sampling qualities, reference is made to FIG. 2D, where the sampling frequencies and harmonics for the preferred luminance patten are graphically illustrated in frequency space. By virtue of uniformity of the preferred luminance sampling pattern, the horizontal and vertical sampling rates are equal. The Nyquist or usable frequency region, i.e., the region including frequencies closer to the origin than to the sampling frequencies, is located in a substantially square portion of the frequency space (indicated by a dashed line) having its diagonals aligned with the horizontal and vertical directions (hence extending further in those directions).

Referring now to FIGS. 3A and 3B, a preferred imaging apparatus for implementing the invention employs a solid state imaging array 20 of the CCD type comprised of individual sensor elements (e.g., element 22 extending between the dashed lines of FIG. 3A). A filter mosaic 24 is superposed on imaging array 20, which mosaic includes individual filters (e.g., filter 26) in one-to-one registration with individual sensor elements of the array (e.g., the element 22). Individual filters of mosaic 24, forming a filter mosaic over the array 20, are of the selectively transmitting type, and are arranged in patterns as described above. The letters G, R, B on individual filters of mosaic 24 (FIGS. 3A and 3B) serve to indicate green, red, and blue light transmission characteristics, respectively, as would be employed according to the presently preferred form of the invention. Filters selectively transmissive to light in the green region of the spectrum are utilized in producing luminance-sensitive elements, and red and blue

transmitting filters are used for producing first and second chrominance-sensitive elements.

A selectively sensitive, color imaging element, such as element 26, is formed by each one of filters 24 in combination with a corresponding array sensor (for element 26 the sensor denoted 22). It will be appreciated, however, that an array according to the invention might also be formed of sensors having selective wavelength sensitivity; or by use of lenticular filters separate from an array of sensor elements, which filters selectively limit the wavelengths of light arriving at individual elements of such array.

Referring to FIG. 4, a color imaging array 30 according to the invention is shown in a simplified camera environment. Image information from individual rows of the array, such as a row 32, is transferred to a shift register 34 (generally formed "on board" the imaging chip) in response to signals from an interrogating apparatus such as a line scan clock 36. Such operation is well known, and apparatus for performing same is described in literature and patents regarding CCD arrays. It is also generally known to process the output signal of the register by means of a circuit 38. Using color imaging arrays according to the invention, however, information for the various base color vectors is interspersed as a result of the intermixed sensitivities of the color array elements. Accordingly, a switching network 40 is provided to separate the image signal sequence to a usable form, for example, to parallel green, red, and blue video signals.

In such form, the signals are conveniently converted to NTSC format using a conversion matrix of 2. This is especially convenient if the number of rows in the array corresponds to the number of visible lines in a field scan (approximately 250) or the number of visible lines in a frame (approximately 500) comprised of interlaced fields.

A simplified diagram for a switching network 30 is shown in FIG. 5. Sample and hold units 50 and 52 are employed in alternating operation to separate out, respectively, green information and the chrominance information. The latter alternates between red and blue with each successive row of the array. Since red information and blue information is received on an alternating row basis, such information is stored in a register 54 for an entire row and shifted out serially as the next row's luminance information arrives.

To maintain the same output channels for red information and blue information, irrespective of row, switching means 56 alternates the output connection from the register with each row of output information.

An important alternative set of patterns for implementing color imaging arrays according to the invention is shown in FIG. 6. The luminance (green) pattern, having elements denoted by a "G", assumes every other array position. A red pattern, having elements denoted by an "R", alternates with luminance elements (denoted "B") in alternate rows, and red elements also alternate with blue elements in filling the remaining element positions. By this arrangement, blue elements contribute only one-eighth of the element population . . . a recognition of the human visual system's relatively limited ability to discern blue detail. Red detail, to which the human visual system is more responsive, is sampled at a higher rate than for blue detail by virtue of the relatively greater population of red-sensitive elements. Luminance detail, to which the human eye is most responsive, is sampled by the largest population of

elements. Through this arrangement, image sampling is coordinated to closely match the response of the human visual system; however, it will be appreciated that separating and storing red and blue image information becomes more complicated when the red and blue patterns differ.

The invention has been described in detail with particular respect to implementations thereof, but it will be appreciated that variations and modifications can be effected within the spirit and scope of the invention. For example, a variety of sensors might be employed, including the sensors of CCD or CID imaging arrays. Moreover, color-sensitive elements for use in the invention may have inherent selective sensitivity or may incorporate filters either adjacent to or removed from a broad-wavelength-range sensor, which filters selectively limit the range of sensitivity for individual sensors. Also, while the invention is cast in the environment of a camera utilization, it has other uses, for example, in connection with a display device.

What is claimed is:

1. A color imaging device comprising an array of light-sensitive elements, which array includes at least (1) a first type of element sensitive to a spectral region corresponding to luminance, (2) a second type of element sensitive to one spectral region corresponding to chrominance, and (3) a third type of element sensitive to a different spectral region corresponding to chrominance, the three types of elements occurring in repeating patterns which are such that over at least a major portion of said array luminance-type elements occur at every other element position along both of two orthogonal directions of said array.

2. A device in accordance with claim 1 wherein said luminance-type elements are sensitive in the green region of the spectrum, and the two types of chrominance elements are sensitive in the red and blue regions of the spectrum, respectively.

3. An array in accordance with claim 1 wherein the elements are arranged in a substantially rectangular pattern and the two chrominance types of sensors alternate with the luminance sensors in alternate rows, respectively, of the rectangular pattern.

4. A color image sensor comprising:

a. a substantially planar array of solid state light-sensitive elements; and

b. a filter mosaic made up of individual filter elements which are superposed in one-to-one registry on said light-sensitive elements, said mosaic being comprised of a first type of filter element having a luminance transparency characteristic, a second type of filter element having a transparency characteristic different from that of said first type, and a third type of filter element having a transparency characteristic different from that of said first and second types, such filter elements being arranged in repeating patterns respective of type with the luminance filters occurring at every other array position in two perpendicular directions throughout substantially the entire imaging area of the sensor.

5. A sensor according to claim 4 wherein the first type filters are arranged at every other array position, and said second and third type filters alternate with the first type filters in respective alternate rows of the array.

6. A sensor according to claim 4 wherein the first type filters occur at every other array position, and the

third type filters occur in alternate rows at every fourth position, the second type filters occurring at all remaining positions, whereby a hierarchy of distributed sampling populations is provided.

7. A sensor according to claim 6 wherein the first type of filter transmits for the green spectral range, the second type of filter transmits for the red spectral range, and the third type of filter transmits for the blue spectral range.

8. A video image sensor comprising a first type of element sensitive to a luminance region of the spectrum, and a second and a third type of element sensitive to respective different chrominance regions of the spectrum, said sensor, over substantially the entire imaging area thereof, having such elements arranged as a mosaic of individual groups of four neighboring elements in a generally square configuration, which groups each include two diagonally-arranged first-type elements, one second-type element, and one third-type element.

9. A video image sensor according to claim 8 wherein said first-type elements within the individual groups are aligned in a common diagonal direction.

10. A video image sensor according to claim 9 wherein said first-type element is sensitive to the green region of the spectrum, the second-type element is sensitive to the red region of the spectrum, and the third-type element is sensitive to the blue region of the spectrum.

11. An image sensor according to claim 8 wherein individual first-, second-, and third-type elements are comprised of a broad spectrum photoresponsive device with a spectrally selective filter superposed in registry therewith.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,971,065

DATED : July 20, 1976

INVENTOR(S) : Bryce E. Bayer

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, lines 56-60: Change sentence to read: --A red pattern, having elements denoted by an "R", alternates with blue elements (denoted "B") in alternate rows, and red elements fill the remaining element positions.--

Signed and Sealed this

Fifth **Day of** *September 1978*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

DONALD W. BANNER
Commissioner of Patents and Trademarks

18602-06614 : A5

United States Patent [19]

Hurd, III et al.

[11] **3,814,227**

[45] **June 4, 1974**

[54] **MATRIX PRINT ROTATION**

[75] Inventors: **Edward T. E. Hurd, III**, Cinnaminson, N.J.; **David M. Stern**, Merion Station, Pa.

[73] Assignee: **Honeywell Inc.**, Minneapolis, Minn.

[22] Filed: **Sept. 27, 1972**

[21] Appl. No.: **292,618**

[52] **U.S. Cl.** .... **197/1 R**
[51] **Int. Cl.** **B41j 3/50**
[58] **Field of Search** .... 197/1; 101/93 C; 340/172.5

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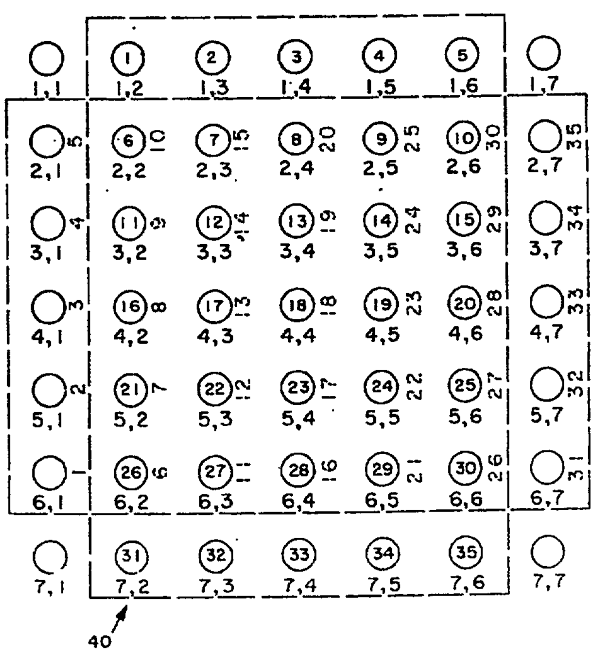
Primary Examiner—Robert E. Pulfrey
Assistant Examiner—R. T. Rader
Attorney, Agent, or Firm—Arthur H. Swanson; Lockwood D. Burton; Mitchell J. Halista

[57] **ABSTRACT**

A printer using a matrix of printing elements arranged in a square configuration with the printing elements being used to print alpha-numeric data in either a vertical or horizontal orientation by electronically selecting a rectangular matrix from less than the full number of printing elements in the square matrix to permit selective orientation of the printed data without mechanically reorienting the print head. The print element drive circuitry also enables the printing matrix to print from either end of the selected rectangular print matrix in either the horizontal or vertical orientation to provide four possible orientations of the printed alpha-numeric data. A memory is used to store the input control signals for each of the rows of the rectangular printing matrix while a control means is provided for reading out the control signals in either direction from the memory in combination with a matrix selection control to provide energization of a rectangular print matrix in either the horizontal or vertical configuration.

10 Claims, 3 Drawing Figures



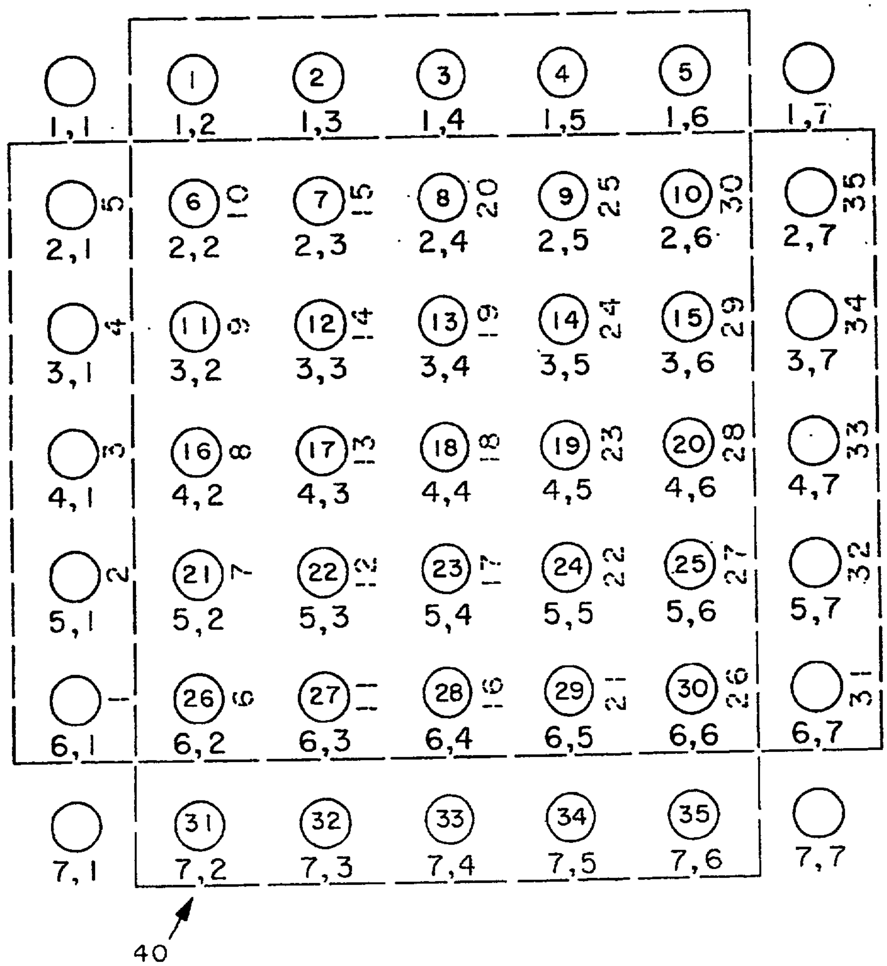

1 2 3 4 5
1,1 1,2 1,3 1,4 1,5 1,6 1,7
6 7 8 9 10
5 10 15 20 25 30 35
2,1 2,2 2,3 2,4 2,5 2,6 2,7
11 12 13 14 15
4 9 14 19 24 29 34
3,1 3,2 3,3 3,4 3,5 3,6 3,7
16 17 18 19 20
3 8 13 18 23 28 33
4,1 4,2 4,3 4,4 4,5 4,6 4,7
21 22 23 24 25
2 7 12 17 22 27 32
5,1 5,2 5,3 5,4 5,5 5,6 5,7
26 27 28 29 30
1 6 11 16 21 26 31
6,1 6,2 6,3 6,4 6,5 6,6 6,7
31 32 33 34 35
7,1 7,2 7,3 7,4 7,5 7,6 7,7
40

FIG. 1

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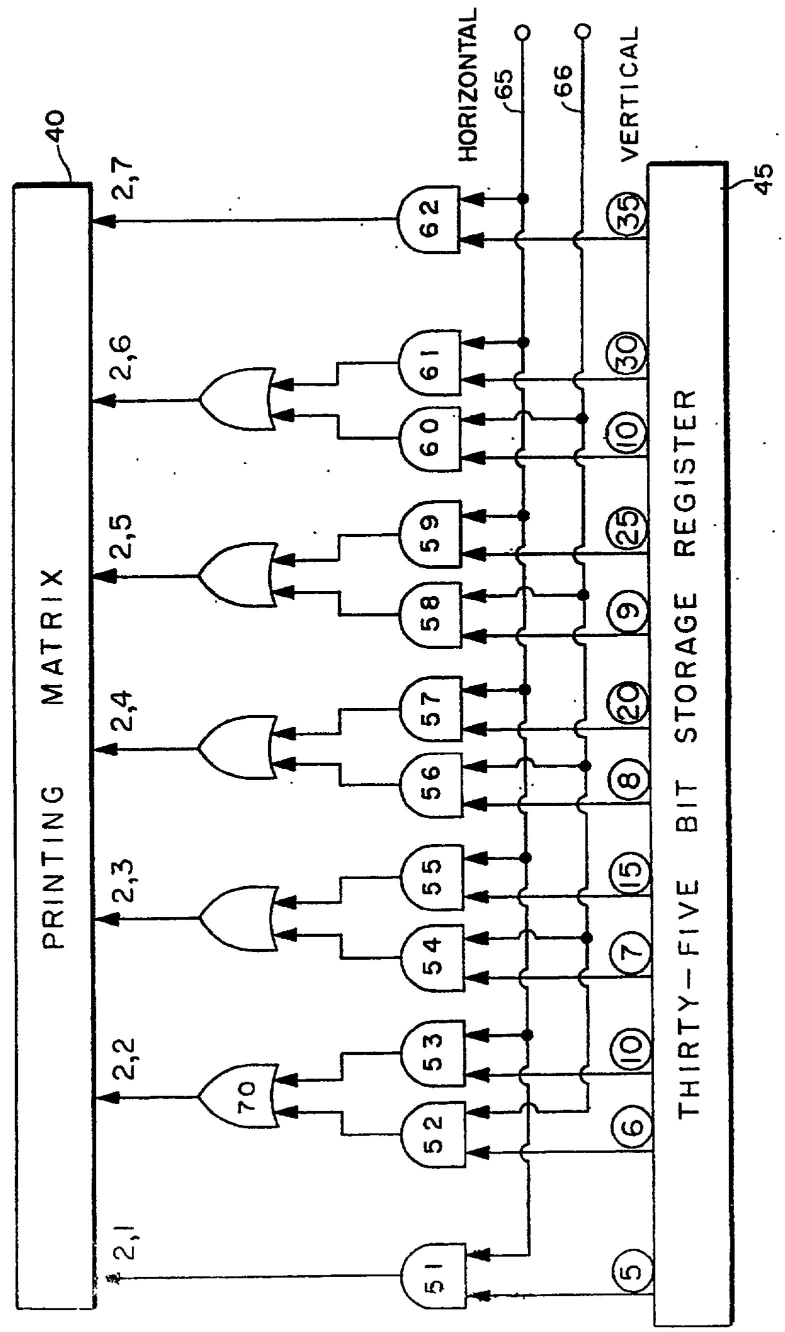
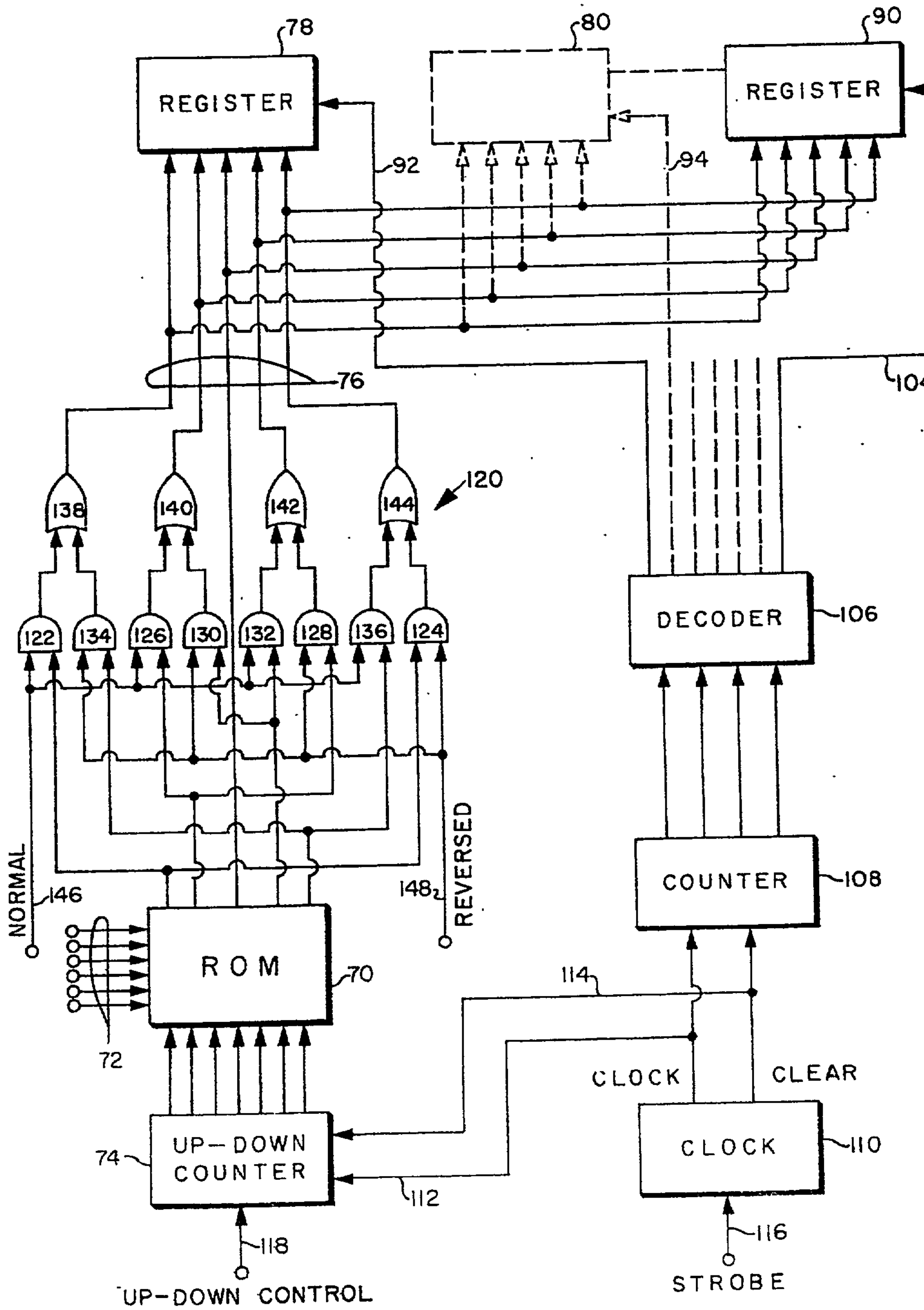


FIG. 2

FIG. 3


78
REGISTER
80
90
REGISTER
92
94
76
104
120
138
140
142
144
122
134
126
130
132
128
136
124
DECODER
106
COUNTER
108
NORMAL
146
148
REVERSED
ROM
70
72
114
CLOCK
CLEAR
CLOCK
110
UP-DOWN COUNTER
74
112
118
UP-DOWN CONTROL
116
STROBE

input for AND gate **52** is obtained from the sixth storage stage of the storage register **45** while a second input for the AND gate **52** is obtained from the vertical control line **66**. Concurrently, a first input for the second AND gate **53** associated with the same print element **2, 2** is obtained from the tenth storage stage of the storage register **45** while a second input for the AND gate **53** is obtained from the horizontal control line **65**.

The output signals from the AND gates **52** and **53** are applied to a first OR gate **70** with the output signal from the OR gate **70** being applied as an energizing signal to the print element **2, 2**. Thus, for example, the presence of a control signal on the horizontal control line **65** and the presence of a digital bit stored in the tenth storage stage of the storage register **45** is effective to energize the print element **2, 2** while a control signal on the vertical control line **66** and a digital bit stored in the sixth stage of the storage register **45** is effective to, also, energize the print element **2, 2**. It should be noted, however, that the print element **2, 2** is matrix element number **6** in the vertical print head orientation and is matrix element number **10** in the horizontal print head orientation. The print elements **2, 2** to **2, 6** are similarly energized from digital bit signal stored in respective pairs of stages in the register **45** as controlled by the horizontal and vertical control lines **65** and **66**. On the other hand, the first print element **2, 1** in the second horizontal row is used only in the horizontal rectangular matrix orientation and is energized by an output signal from the first AND gate **51** in response to a bit stored only in the fifth stage of the register **45** and the presence of control signal on the horizontal control line **65**. Similarly, the last print element **2, 7** in the second horizontal row is energized by an output signal from the last AND gate **62** in response to a bit stored only in the 35th stage of the register **45** and the presence of a control signal on the horizontal control line **65**. This scheme of energizing the print elements is applicable to all of the print elements shown in FIG. **1** except those in the first and last rows, i.e., print elements **1, 1** to **1, 7** and print elements **7, 1** to **7, 7** and those in the first and last columns, elements **1, 1** to **7, 1** and elements **1, 7** to **7, 7**. Specifically, the corner print elements **1, 1; 1, 7; 7, 1** and **7, 7** may be either unused or selectively energized to provide special print notations by any suitable circuits (not shown) since these print elements do not form a part of either rectangular print matrix. Additionally, the remaining print elements first and last rows, i.e., print element **1, 2** to **1, 6** and print elements **7, 2** to **7, 6** are used only in the vertical orientation and, accordingly, are energized by the concurrent presence of a vertical control signal and a digital bit stored in the stage of the register **45** corresponding to the position of these print elements in the vertical print matrix as identified by the reference numbers in FIG. **1**. The vertical control signal and digital bits for controlling these print elements would be applied to AND gates in a manner similar to that described above for AND gates **51** and **62** shown in FIG. **2**. Similarly, the print elements in the first and last columns **2, 1** to **6, 1** and **2, 7** to **6, 7** are used only in a horizontal orientation and, accordingly are energized by the concurrent presence of a horizontal control signal and a digital bit stored in the stage of the register **45** corresponding to the position of these print elements in the horizontal print matrix. Finally, it should be noted that a storage position in the register **45** may be used to energize a print element in a different position in the horizontal print matrix from that in the vertical print matrix, e.g., storage position **10** is used for print elements **2, 2** and **2, 6**.

In FIG. **3**, there is shown a block diagram of a control circuit for the matrix drive circuit shown in FIG. **2**. The print element drive pattern which drives the printing matrix is derived from a read-only memory **70**. Thus, a particular symbol pattern to be displayed by a 5 × 7 printing matrix is selected from the read-only memory **70** by a character code selection signal applied to input lines **72** derived from any suitable source, e.g., an encoding typewriter keyboard. In the arrangement shown in FIGS. **2** and **3** the 5 × 7 matrix symbol pattern is read out of the memory **70** one row at a time with successive memory addresses being required to read out the successive rows of the pattern data. These successive addresses are produced by an up-down counter **74**. The output signals from the memory are applied in five parallel data lines **76** for application to a storage register. These data lines represent the five columns of data contained within one row of a 5 × 7 matrix. The output signals from the memory **70** are applied in parallel to seven five-bit registers **78** to **90** which are shown in only partial representation in FIG. **3** for the sake of clarity and which correspond in total to the register **45** shown in FIG. **2**. However, each of the registers are successively enabled for loading of the output signals from the read-only memory **70** by successive output signals applied on respective register select lines. For example, the first register **78** is enabled by a select signal applied on a first register select line **92** while the last register **90** is enabled by a register select signal applied on a select line **104**. The select lines **92** to **104** are successively energized by a decoder circuit **106** which, in turn, is driven by a four-bit counter **108**. The decoder circuit **106** may be any suitable prior art device for translating the count in the counter **103** into successive energizations of the select lines **102** to **104**. The counter **108** and the counter **74** are both driven by clock signals from a clock source **110** supplied over a clock signal line **112**. Similarly, the counter **74** and **108** are "cleared" by a "clear" signal from the clock source **110** applied on a clear signal line **114**. The signals from the clock **110** are initiated upon receipt of a "strobe" pulse on a strobe input line **116** from any suitable means (not shown) which is used to initiate the printing cycle after the selection signals on lines **72** are applied to the memory **70**.

In operation, the control circuit shown in FIG. **3** is effective to start the printing of a character after the selection of a character by the signals on lines **72** by a "strobe" pulse applied on the strobe line **116** to the clock **110**. The "strobe" may be derived from the same source used to produce the selection signals on lines **72** and may be applied concurrently therewith to the circuit shown in FIG. **3**. This "strobe" pulse produces a "clear" pulse from the clock **110** which is applied to the counters **74** and **108**. Subsequently, the clock **110** is arranged to produce a burst of seven clock pulses on clock line **112** for application to the counters **74** and **108** to increment the counters concurrently. The successive count signals stored in the counter **108** in response to the clock pulses are decoded by the decoder **106** to successively enable the registers **78** to **90**. Concurrently, the clock signals applied to the counter **74** are applied to the read-only memory **70** as address signals for each of the seven rows of the data pattern for

a 5 × 7 matrix which has been selected by the input signals on input lines 72. In order to further increase the printing abilities of the printer, the counter 74 is arranged to be an up-down counter which under control of an up-down control signal applied on a control line 118 will either increment or decrement its count with the receipt of each clock pulse on clock line 112. In other words, when the up-down counter 74 is in an up-count mode, the rows in the read-only memory 70 for the selected character pattern are read out in order from 1 through 7. Conversely, when the counter 70 is in a count-down mode, the selected character pattern in the read-only memory 70 is read out in order from row 7 through 1. Therefore, in the count-down mode of the counter 74 the data pattern from the read-only memory is read out to print a character which the reverse of a character printed by a count-up mode of the counter 74. Accordingly, the combination of the signal on the up-down control line 118 and the vertical and horizontal control as shown in FIG. 2 permit a 5 × 7 character pattern to be displayed in any one of four possible orientations, i.e., the character can be normal or reversed in the horizontal print configuration and either normal or reversed in the vertical print configuration.

In order to correctly print the characters in the reversed mode in either the horizontal or vertical configuration to avoid a mirror-image printing, the circuit shown in FIG. 3 uses a set of AND-OR gates 120 interposed in the output lines 76 from the ROM 70 to produce either a left-to-right or a top-to-bottom reversal of the character pattern. Specifically, the first output line from the ROM 70 is connected to a first AND gate 122 and a second AND gate 124. A second output line from the ROM 70 is connected to a third AND gate 126 and a fourth AND gate 128. The third output line from the ROM 70 is passed directly to the output lines 76 since it determines the center of the character which is not affected by the reversed mode. The fourth output line from the ROM 70 is connected to a fifth AND gate 130 and a sixth AND gate 132. The fifth output line from the ROM 70 is connected to a seventh AND gate 134 and an eight AND gate 136. The outputs of the first and eight AND gates 122 and 134 are connected to a first OR gate 138 having an output line connected to a first one of the output lines 76. The outputs from the third AND gate 126 and the fifth AND gate 130 are connected to a second OR gate 140 having its output line connected to a second one of the output lines 76. The outputs from the sixth AND gate 132 and the fourth AND gate 128 are connected to a third OR gate 142 having its output connected to a fourth one of the output lines 76. Finally, the output of the eighth AND gate 136 and the second AND gate 124 are connected to a fourth OR gate 144 having its output connected to fifth one of the output lines 76. A pair of control signal lines 146 and 148 are used to control the normal and reversed mode of operation, respectively. These control lines 146 and 148 are used to apply energizing signals to predetermined ones of the AND gates in the set of AND-OR gates 120 to route the output signals from the ROM 70 to desired ones of the output lines 76.

Specifically, the "normal" control line 146 is connected to the AND gates 122, 126, 132 and 136 while the "reverse" control line 148 is connected to the AND gates 124, 128, 130 and 134. Consequently, the first and second output lines of the ROM 70 can be selectively connected to either the fourth and fifth ones of the output lines 76 or the first and second ones of the output lines 76. The aforesaid interchange of the first and second output lines of the ROM 70 with the fourth and fifth output lines of the ROM 70 are effected concurrently by a signal on either one of the control lines 146 and 148. This interchange has the net effect of rotating the character pattern around the pattern center represented by the third output line from the ROM 70 which is connected directly to the third output line of the output lines 76. The control signals on the control lines 146 and 148 are related to the up-down control signal on the up-down control line 118 since in the count-up mode of operation of the counter 74, the "normal" control signal on line 146 would be applied to control the routing of the output signals from the ROM 70 while the "reverse" control signal on line 148 would be applied during the count-down mode of operation of the counter 74.

Accordingly, it may be seen that there has been provided, in accordance with the present invention, an improved matrix printer for printing alpha-numeric data oriented along a vertical axis as well as a horizontal axis without involving mechanical reorientation of a print head.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A printer comprising:

a print head having a fixed spatial arrangement of a plurality of printing elements,

selection means for selecting a plurality of groups of said printing elements out of said fixed spatial arrangement to form each of a corresponding plurality of printing matrices with each of said plurality of printing matrices being rotatably displaced from any other one of said plurality of printing matrices,

energizing means for generating energizing signals for said printing elements to actuate said printing elements to form corresponding printed representations by said printing elements, and

energizing signal means for selectively applying said energizing signals to said printing elements in a printing matrix selected by said selection means from said plurality of printing matrices.

2. A printer as set forth in claim 1 wherein said fixed spatial arrangement is a square with the same number of printing elements on each side of the square and each printing matrix selected by said selection means from said plurality of printing matrices is a rectangle with a different number of printing elements on adjacent sides of the rectangle and

including control means selectively operable to control said selection means for switching between a first rectangular printing matrix and a second rectangular printing matrix rotatably displaced from said first rectangular printing matrix.

3. A printer as set forth in claim 1 wherein each selected print matrix has less than all of the available print elements.

4. A printer as set forth in claim 1 wherein said fixed spatial arrangement is a square with the same number of printing elements on each side of the square and said printing matrix is a rectangle with a different number of printing elements on adjacent sides of the rectangle and including a control means selectively operable to

control said selection means for switching between a first rectangular printing matrix and a second rectangular printing matrix angularly displaced from said first rectangular printing matrix.

5. A print as set forth in claim 4 wherein said first and second rectangular printing matrices of printing elements have the same number of print elements.

6. A printer as set forth in claim 4 wherein said first and second rectangular printing matrices are displaced 90° from each other.

7. A printer as set forth in claim 1 wherein said energizing means includes a memory means for storing control signals for said print elements and readout means arranged to read out said control signals from said memory means for application to the printing elements selected by said selection means as energizing signals.

8. A printer as set forth in claim 7 wherein said readout means includes an up-down counter arranged to read out said control signals from said memory means, signal generating means, means for applying output signals from said signal generating means to said up-down counter to be counted thereby and means for controlling the counting direction of said up-down counter during the counting of the output signals from said signal generating means and means for applying count signals stored in said up-down counter means to said memory means to readout said control signals from said memory means in response to said count signals whereby said control signals from said memory means are read out in either a first sequence during an up counting operation of said counter or a second sequence during a down counting operation of said counter.

9. A printer as set forth in claim 4 wherein said energizing means includes a memory means for storing control signals for said print elements and readout means arranged to read out said control signals from said memory means as energizing signals for application to the printing elements selected by said selection means.

10. A printer as set forth in claim 9 wherein said readout means includes an up-down counter arranged to read out said control signals from said memory means, signal generating means, means for applying output signals from said signal generating means to said up-down counter to be counted thereby and means for controlling the counting direction of said up-down counter during the counting of the output signals from said signal generating means and means for applying count signals stored in said up-down counter means to said memory means to readout said control signals from said memory means in response to said count signals whereby said control signals from said memory means are read out in either a first sequence during an up counting operation of said counter or a second sequence during a down counting operation of said counter.

* * * * *

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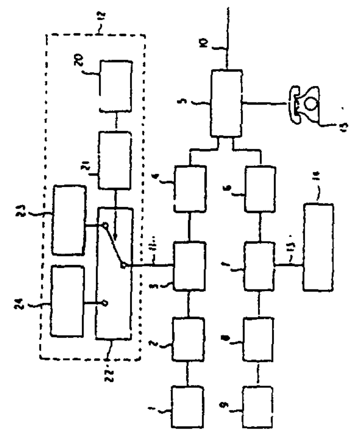
(54) **VIDEO TELEPHONE SYSTEM**
(11) 4-120889 (A) (43) 21.4.1992 (19) JP
(21) Appl. No. 2-239909 (22) 12.9.1990
(71) HITACHI LTD (72) KATSUMI OKUMA(2)
(51) Int. Cl⁵. H04N7/14,H04N5/225

PURPOSE: To unnecessitate any external device and to miniaturize the system by providing a rotating mechanism to be rotated within one plane and a control circuit for changing an order to read a frame memory.

CONSTITUTION: This system is equipped with a television camera 1, preprocessing circuit 2, frame memories 3 and 7, encoder circuit 4, transmission interface 5, decoder circuit 6, post-processing circuit 8, display 9, transmission line 10, addresses 11 and 13, frame memory address control circuits 12 and 14 and main body 15 of a telephone set. When inputting a drawing, the direction of the television camera 1 is axially rotated within one frame in comparison with the case of inputting the own image of a speaker by an image pickup direction rotation part 20, and according to the direction of an object, the order to read or write picture signals from the television camera 1 to the frame memories 3 and 7 is changed. Thus, any additive device is unnecessitated, and system scale can be reduced as a whole.



21: image pickup direction rotation detection part. 22 object select switch. 23: address counter for figure. 24 address counter for drawing

⑲日本国特許庁（ＪＰ）　　⑪特許出願公開

⑫公開特許公報（Ａ）　平4－120889

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5/225	Z	8942－5C	

審査請求　未請求　請求項の数 5　（全5頁）

⑭発明の名称　テレビ電話装置

㉑特　願　平2－239909

㉒出　願　平2(1990)9月12日

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明　細　書

1．発明の名称

テレビ電話装置

2．特許請求の範囲

1．電話器本体と、通話する相手側の画像を表示するディスプレイと、通話する相手側に送る被写体を撮影するテレビカメラと、上記テレビカメラで撮影された画像信号を記録するフレームメモリとを備えたテレビ電話装置において、

上記テレビカメラの向きを上記被写体の変化に応じて回転する手段、被写体の変化を検出する手段と、被写体の変化に応じて上記フレームメモリへの書き込み又は読みだしの順序を切り換える手段とを有することを特徴とするテレビ電話装置。

2．請求項第1記載において、上記被写体の変化を検知する手段はテレビカメラの向きの変化によることを特徴とするテレビ電話装置。

3．請求項第1記載において、上記被写体が人物及び書画であって、上記フレームメモリへの書き込み又は読みだしの順序を切り換える手段が上記テレビカメラ出力信号の画像のパターンによって切り替えを行なう手段を有することを特徴とするテレビ電話装置。

4．請求項第1記載において、上記被写体が人物及び上記人物にほぼ直交する位置に配置される書画であって、上記テレビカメラの向きを回転する手段が回転軸にたいしてほぼ90°回転するように構成されたことを特徴とするテレビ電話装置。

5．撮像方向が平面内で変わり旋回もするテレビカメラと、上記テレビカメラからの画像信号を記憶するフレームメモリと、上記フレームメモリから読みだされた画像信号を符号化してテレビ画像信号を作る回路と、上記テレビカメラの撮像方向を検出する位置検出手段と、上記位置検出手段の検出したテレビカメラの撮像方向に対応して上記フレームメモリの読みだし又は書き込み順を切り替える手段とを持つテレビ[illegible]

発生装置。

3．発明の詳細な説明。

【産業上の利用分野】

本発明はテレビ電話装置，特に電話通話者の画像と通話者の近くに置かれた書画等の画像を切り換えて音声と共に画像を伝送するテレビ電話装置に関する。

【従来の技術】

テレビ電話は、電話器本体のほかに通話する相手側の画像を表示するディスプレイと、通話する相手側に送る画像を撮影するテレビカメラとを備えて構成される。ところで，通常の会話時に通話者の自己画像を伝送する以外に、書画等の画像を伝送し、その書画について会話したい場合がある。通話者、書画それぞれの被写体の特徴として、通話者はディスプレイに向き合う位置にあるのに対して，書画は通常机等の上に通話者に対して垂直に置かれ，通話者がその書画を見ながら会話できるように通話者の方に書画の下側が配置されることがあげられる。

この異なる性質の被写体に応じて画像入力の方向を変える必要がある。つまり，通話者の自己の画像を送るときにはディスプレイの表示面と対向する方向から、書画を送るときにはテレビ電話の置いてある台の面方向からテレビカメラに画像を入力する必要がある。

画像入力の方向を変えるには次の方式が知られ、または考えられる。

（1）人物用カメラと書画用カメラを用意し，被写体に応じて切り換える方式。

（2）カメラを自由に動かせるようにして、（装置本体から取り外し可能にすることを含む。）被写体に応じてカメラの向きを変える方式。

（3）書画入力時にはミラー等光学的手段により画像入力の向きを変える方式（特許公開公報、特開平2－9282号）。

【発明が解決しようとする課題】

上記（1）の方式は，カメラが2個必要になり全体としての装置規模が増加する。また、カメラからの映像信号入力が2系統生じ，この信号の切

り替えを行なう信号処理が必要となる，この理由からも回路規模が増大する。

上記（2）の方式は，1個のカメラで画像入力が可能となるが，カメラを取り外し可能にした場合，書画等静止した被写体に対してはカメラを固定する手段が必要となる。また、取外しを行なわない場合でも通話者のほうに書画の下側が向けられるためにはカメラを水平方向に180度，垂直方向に90度動かす必要があり、そのための機械的な動作部分が多くなり装置の構成及び操作が複雑になる問題がある。

上記（3）の方式は．テレビカメラの外部に光学系が必要となり全体としての装置規模が増加する問題がある。

従って，本発明の主な目的は、外部装置を不要とし，装置の機械的な動作部分を最小限にすることにより、装置の小型経済化を達成する手段を提供することにある。

【課題を解決するための手段】

上記目的を達成するため、本発明は

（1）書画を入力する場合にはテレビカメラの向きを通話者の自己の画像の入力時に対し，1平面内で軸回転する機構を設ける、

（2）被写体の変化により　テレビカメラからの画像信号のフレームメモリへの書き込み又は読みだし順序を変える手段を設ける。

本発明の好ましい態様においては、被写体の変化をテレビカメラの向きの変化により検出する手段を設ける。

1平面内で軸回転する機構は、テレビ電話の性質上、話者が書画を見やすい位置と画像の歪みが少ないようカメラの固定位置をほぼ90°の回転を行なって固定することが望ましい。

【作用】

本発明のテレビ電話では、前記（1）の手段により、テレビカメラの機械的な動作部分を最小限に押さえることができる，しかし，第4図で説明するように，テレビカメラを90度下方に回転しただけでは，通話者がその書画を見ながら会話ができるように通話者のほうに書画の下側が向けら

れる場合、画像の走査において、書画の上下が逆転する。

そこで上記（2）の手段により、フレームメモリの書き込み又は読み出しの順序とは逆にする事ができる。

よって、1平面内で回転する回転機構とフレームメモリの読み出しの順序を変える簡単な制御回路を設けるのみで良く、従来の技術の例（2）で述べたようなテレビカメラ水平方向及び垂直方向の両方の回転動作を必要としない。

［実施例］

以下、本発明の実施例を図面を用いて説明する。

第1図は本発明によるテレビ電話の1実施例の全体構成図である。

同図において、点線で囲まれた部分が本発明の特徴部分で、他の部分は従来のものと同様である。

まず、従来部分を簡単に説明する。このテレビ電話は、カメラ装置2、フレームメモリ3、7符号化回路4、伝送インターフェイス5、復合化回路6、後処理回路6、ディスプレイ9により構成

されている。

テレビカメラ1からの信号は前処理回路2で映像信号に変換された後、フレームメモリ3に映像信号が入力され、符号化回路4にて圧縮符号化される。フレームメモリ3のアドレス11はフレームメモリアドレス制御回路12により生成される。符号化された信号は、伝送インターフェイス5にて所定の伝送信号に変換され、伝送信号が伝送路10を介して通話する相手側端末に伝送される。伝送路10を介して相手側から送られてきた映像信号は伝送インターフェイス5を介して復号化回路6に入力され、複号化された後、フレームメモリ7に書き込まれる。フレームメモリ4のアドレス13はフレームメモリアドレス制御回路14により生成される。フレームメモリ4のデータは後処理回路8にてディスプレイ9への映像信号に変換される。これによりディスプレイ装置9へは相手側の画像が表示される。電話機本体15は伝送インターフェイス5を介して相手との音声通話を行なう。

次に本発明に係る部分（点線内）を説明する。

この装置の動作モードとしては通話者の画像を送受する人物モードと書画の画像を送受する書画モードとがある。

まず、本発明の第1の特徴である「撮像方向回転部」20を、第4図を用いて説明する。

（1）人物モードにおいては、撮像部は通話者の方向、即ちカメラが通話者に対向し、通常はディスプレイの表示画面の方向に向いている。

（2）書画モードにいては、撮像部は書画の方向、即ち下の方向に向いている。

このことにより、被写体である通話者及び書画の位置を変えず、カメラを回転軸を中心に約90°回転するのみで、画像入力の切り替えを行なうことができる。

なお、書面の位置は上記位置に限定されるものではなく、テレビカメラを対象点として通話者の反対位置に有る場合も、本発明は同様の効果を持つことは明らかである。

次に本発明の第2の特徴である「フレームメモ

リアドレス制御回路」12を第1図、第2図及び第3図を用いて説明する。

（1）撮像方向回転部20の変化は、撮像方向回転検出部21により検出され、人物モード、書画モードが判定される。判定結果により、撮像方向回転検出部21に連動した被写体スイッチ22が適宜切り替えられる。この信号により人物用アドレスカウンタ23と書画用アドレスカウンタ24の一方が選択される。

（2）カメラの走査が第2図のような順序、即ち垂直方向の上から下に、水平方向の左から右へ行なわれているとする。人物モードでは　フレームメモリ3への書き込み及び読み出しは第2図のようにカメラの走査と同じ順序で行なわれる。

（3）書画モードでは、フレームメモリへの書き込みは第3図のようにカメラの走査と逆の順序、即ち垂直方向の下から上に、水平方向の右から左へ行なわれる。読み出しは第2図のようにカメラの走査と同じ順序で行なわれる。

（4）これにより符号化回路以降の映像信号は見

かけ上、上下の正しい信号となる。従って、受信側では装置に何の変更も加えることなく正しい向きの画像を得ることができる。

なお、(3)において、フレームメモリ3への書き込みは第2図のカメラの走査と同じ順序で行ない、読み出しは第3図のようにカメラの走査と逆の順序で行なっても同様の効果が得られる。

以上本発明の1実施例について説明したが、本発明は上記実施例に限定されるものではなく、第5図に示すごとく、テレビカメラの軸回転平面に有る複数の被写体16、17、18、(例えば、計測機等)の映像を単一のカメラで撮像方向を切り替えて撮像し、伝送する場合にも適用される。更に、以下の形態も本発明に含まれるものである。

(1)フレームメモリ3への書き込み及び読み出しの順序を切り替える手段として、実施例では人物用と書画用の2つのアドレスカウンタを設けているが、1つのアドレスカウンタのみを用いて、カウンタのインクリメントとデクリメントを切り替えてもよい。また、ROMの素表により書き込み又は読み出しの順序を切り替えてもよい。

(2)実施例では、カメラの向きの変化は、撮像方向回転検出部に連動した被写体選択スイッチにより検出しているが、パターン認識の手法を用いて入力画像が書画か否かを判定する手段を用いる。

(3)カメラの回転駆動部は手動によってカメラを直接機械的に回転させるもの、スイッチを設けモータで回転させる間接的手段を用いてもよい。

[発明の効果]

上記本発明によると、比較的単純な回路の追加により人物、書画の異なる特徴を持つ被写体に対して1個のカメラで画像の入力ができるようになる。この結果

(1)付加装置が不要になり、全体での装置規模削減が可能となる。

(2)通話者の見易い向きに書画を置くことができ、自然な感覚で書画を見ながら会話を行なうことができる効果がある。

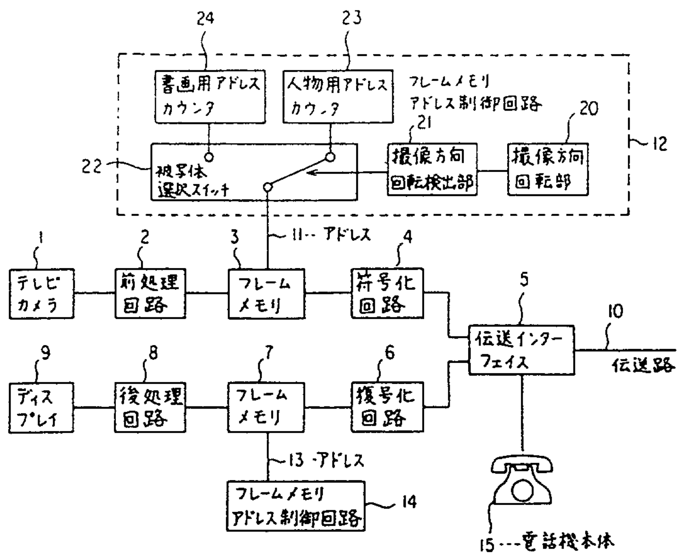
4．図面の簡単な説明

第1図は本発明によるテレビ電話の1実施例の構成を示すブロック図、第2図及び第3図はフレームメモリのアドレスカウンタのアドレス順を説明する図、第4図は本発明によるテレビ電話の実施例におけるカメラと通話者と書画の位置関係を示す図、第5図は本発明の他の実施例におけるカメラと被写体の位置関係を示す図である。

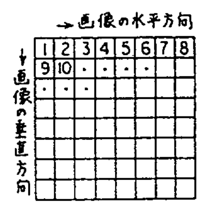
符号の説明

1…テレビカメラ、2…前処理回路、3、7フレームメモリ、4…符号化回路、5…伝送インターフェイス、6…複号化回路、8…後処理回路、9…ディスプレイ、10…伝送路、11、13…アドレス、12、14…フレームメモリアドレス制御回路、15…電話機本体、16、17、18…被写体、20…撮像方向回転部、21…撮像方向回転検出部、22…被写体選択スイッチ、23…人物用アドレスカウンタ、24…書画用アドレスカウンタ。

代理人弁理士 [illegible]田 利 幸



第 1 図



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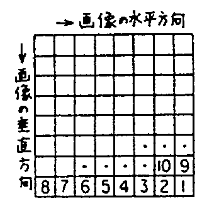

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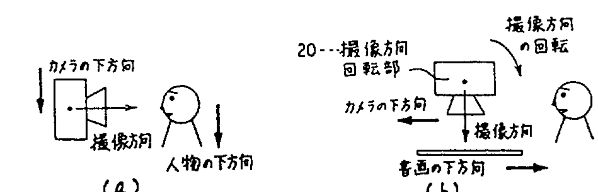

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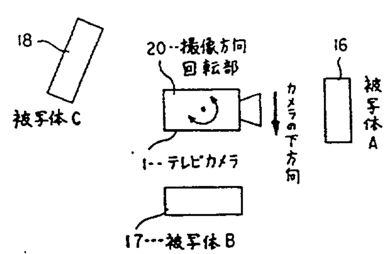

第 5 図

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Application papers not suitable for publication

SN 10040249 Mail Date 01/04/02

☐ Non-English Specification

☐ Specification contains drawing(s) on page(s)__________ or table(s)__________

☐ Landscape orientation of text ☐ Specification ☐ Claims ☐ Abstract

☐ Handwritten ☐ Specification ☐ Claims ☐ Abstract

☐ More than one column ☐ Specification ☐ Claims ☐ Abstract

☐ Improper line spacing ☐ Specification ☐ Claims ☐ Abstract

☑ Claims not on separate page(s)

☑ Abstract not on separate page(s)

☐ Improper paper size -- Must be either A4 (21 cm x 29.7 cm) or 8-1/2"x 11"

- ☐ Specification page(s)__________ ☐ Abstract
- ☐ Drawing page(s)__________ ☐ Claim(s)

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Reason	Section
☐ Paper too thin	☐ Specification page(s)__________
☐ Glossy pages	☐ Drawing page(s)__________
☐ Non-white background	☐ Abstract
	☐ Claim(s)

☐ Drawing objection(s)

- ☐ Missing lead lines, drawing(s)__________
- ☐ Line quality is too light, drawing(s)__________
- ☐ More than 1 drawing and not numbered correctly
- ☐ Non-English text, drawing(s)__________
- ☐ Excessive text, drawing(s)__________
- ☐ Photographs capable of illustration, drawing(s)__________